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THE
PATHOLOGICAL ANATOMY
OF THE EAR
—
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THE
PATHOLOGICAL
ANATOMY OF THE EAR.

BY
HERMANN SCHWARTZE, M. D.,
PROFESSOR IN THE UNIVERSITY OF HALLE a./s.

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WITH THE AUTHOR'S REVISIONS AND ADDITIONS, AND
WITH THE ORIGINAL ILLUSTRATIONS.

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TRANSLATOR'S PREFACE.

SCHWARTZE'S "Pathological Anatomy of the Ear" constitutes the sixth part of Kleb's "Handbook of Pathological Anatomy." It is the only comprehensive work strictly devoted to the pathological anatomy of this organ, and on account of the opportunities and devotion of the author in this special field, his well-known thoroughness and strict impartiality in scientific researches, it is a most valuable addition to the literature of otology. It is essentially a hand-book on the subject of which it treats, a small amount of space often sufficing to give the results of researches, the laboriousness of which can only be appreciated by those who have been engaged in similar work.

The translation is issued, both to show what has already been accomplished in this branch of otology, and with the hope of directing still further attention to pathological anatomy, the only solid foundation for a still further advance in our knowledge of diseases of the ear. It has been the object to repro-

duce the work in the same concise language as the original, together with the additions and corrections which the author has made since the publication of the German edition. The histology of the ear, to which reference is often made, will be found fully described in Stricker's "Manual of Histology" and Koelliker's "Hand-book of Histology."

On account of the large number of references, abbreviations are freely used. The first citation of a work will be found with the full title; in further citations of the same work, abbreviations are often used. Among the most frequent of these abbreviations are A. f. O., for the Archiv fur Ohrenheilkunde, M. f. O., for the Monatschrift fur Ohrenheilkunde, and A. f. A. und O., for the Archives of Ophthalmology and Otology.

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THE PATHOLOGICAL ANATOMY OF THE EAR.

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tubæ, and once he found the tympanum filled with pseudo-membranes. — *Itard*, Traité des Maladies de l'Oreille. Paris, 1821. — *Otto*, Neue seltene Beobachtungen zur Anatomie, Physiologie und Pathologie gehörig. Berlin, 1824. S. 4, 96, 97. — *Beck*, Krankheiten des Gehörorgans. Freiburg, 1827. — *Saissy*, Essai sur les Maladies de l'Oreille interne. Paris, 1827. — *Wittgenstein*, Nonnulla de Anatomia Auris Pathologica. Diss. Inaug. Berlin, 1831. — *Cruveilhier*, Anatomie Pathologique du Corps Humain. 2 vols. Text and Atlas. Paris, 1832-42. — *Lincke*, Handbuch der Ohrenheilkunde. Leipzig, 1837. Bd. I. S. 579-653. — *Hyrthl*, Beiträge zur Pathologischen Anatomie des Gehörorgans. Oesterr. Med. Jahrb. XI. 1838, and in other places. — *Ammon*, Angeborene chirurg. Krankheiten des Menschen. Mit Tafeln. Berlin, 1840. — *Pappenheim*, Specielle Gewebelehre des Gehörorgans. 1840. — *Nuhn*, Commentatio de Vitiis, quæ Surdo-Mutitati subesse solent. Heidelberg, 1841. — *Bochdalek*, Pathologisch-anatomische Untersuchungen der Gehör- und Sprachwerkzeuge bei Taubstummen. Oesterr. Med. Jahrb. 1842, and in other places. — *Kuh*, Klinische Beiträge zur Kenntniss der Entzündung der inneren Abtheilungen des Gehörorgans. Breslau, 1847. — *Guckelberger*, Beiträge zur Pathologischen Anatomie der Entzündung des Hörorgans. Zeitschr. für Chir. und Geburtsh. VII. 3. 1854. — *Rau*, Lehrbuch der Ohrenheilkunde. Berlin, 1856. — *Stanley, Edw.*, Results of Fifty-six Dissections of the Ear. Med.-Chirurg. Transactions, vol. 39. 1856. — *Toynbee*, Catalogue of Museum. 1857. — *Von Troeltsch*, Anatomie des Ohres. 1860.

Also the text books of otology by Wilde (1853), Toynbee (1860), Bonnafont (1860), Von Troeltsch (1st edition, 1862, 6th edition, 1877), Moos (1866), Gruber (1870), etc.; the special journals for ear-diseases, viz., Archiv für Ohrenheilkunde, Monatschrift für Ohrenheilkunde, Annales des Maladies de l'Oreille et du Larynx, Archives of Ophthalmology and Otology; Virchow's Archiv für Pathologische Anatomie, Archiv für Phys. Heilkunde von Wagner, Med. Chirurg. Transactions, Guy's Hospital Reports and articles distributed in innumerable other journals.

Joseph Toynbee († 1866) is considered the founder of the pathological anatomy of the ear. He was the first who, in a thorough and systematic manner, determined the principal pathological changes and established the fact that the majority of these changes were situated in the tympanum, or, as it is more commonly expressed, in the middle ear.

Toynbee published the results of his numerous dis-

sections in the *Medico-Chirurgical Transactions* (1841–1855), and in the *Transactions of the Pathological Society of London* (1849–1856). Somewhat later (1857) they were given in an independent work with the title “*A Descriptive Catalogue of Preparations Illustrative of the Diseases of the Ear in the Museum of Joseph Toynbee*,” and also in his work “*Diseases of the Ear; their Nature and Treatment*,” which appeared in 1860.¹

All that had been done towards the anatomical foundation of aural pathology by the few physicians and anatomists before Toynbee, is but little compared with the mass of his material, and although the scattered facts which have been made known by Valsalva, Duverney, Morgagni, Itard, Hyrtl, and others, are of value, still they are separated, few in number, and relate chiefly to such aural affections as are associated with otorrhœa and lead to direct fatal results.

In the further development of the pathological anatomy of the ear, after Toynbee, German physicians have been principally active, not the anatomists, however, but practicing physicians (Von Troeltsch, Voltolini, Lucae, Politzer, Gruber, Magnus, Zaufal, Moos,

¹ The Toynbee collection of pathological preparations of the ear consists of more than eight hundred specimens, mostly dry, and is now in Hunter's Museum of the College of Surgeons, London. In Germany, except numerous private collections of individual teachers, there only exists, so far as I know, a single large public collection, namely, in the Pathological Institute of Leipzig, where it was formed by the late Wendt and placed under the care of Prof. E. Wagner. For the beginner the inspection of such large collections and of the best preparations is not of so much value as personal dissection. The examination of ear preparations is of the most use for him who made them; for another observer only of value when a number of preparations are placed together for examination of some particular point.

Wendt († 1875), Kessel, and many others). The work of the anatomists is confined to some isolated facts which have been communicated incidentally by Von Meckel, Otto, Bochdalek, Virchow, A. Böttcher, C. E. E. Hoffman, Klebs, Heller, and others. Among the non-German authors, Bonnafont and Hinton († 1875) should be placed in the front rank. In pathological histology of the middle ear, Wendt had labored with particularly good results of late years, but has unfortunately been called from his work by an unexpected early death. The pathological histology of the labyrinth of the ear is still in the first stages of its development, and needs the services of an extraordinary anatomist who must work deeply and thoroughly in this most difficult field for years to bring forth any result. What has been done by some in this field, of late years, with the most earnest endeavors, is scarcely more than a sad dilettanteism, and has no special value for science.

A systematic compilation and revision of the pathological anatomy of the ear has not been attempted since the work by Lincke, who confined himself almost entirely to the history of malformations, and on this account I must beg indulgence for any incompleteness or defect in my work. I desire, however, to lay special stress on the trustworthiness of all the facts which are stated, and to the literary completeness of all cited publications. Where the stated facts are not derived from personal observation and investigation, the result of nearly twenty years' experience in the anatomical and practical study of the human ear, the name of my authority is given in brackets.

A typically normal ear is comparatively seldom found in dissection. In most cases abnormal conditions of congestion and secretion, especially in the middle ear, are met with which are certainly in the majority of cases to be considered as phenomena brought on during the agony, or else as having occurred post-mortem. These changes are quite regularly found in the bodies of those persons who have died from heart and lung diseases and are the result of venous congestion in the branches of the vena cava superior. It is therefore necessary to avoid laying too great a clinical value on these insignificant pathological alterations, especially if they are found on both sides.

The diseases which most frequently affect the ear are the acute exanthemata, typhus, acute and chronic catarrh of the nose and naso-pharynx with their results, tuberculosis, diseases of the heart, syphilis, puerperal fever, and chronic alcoholismus.

In dissecting the ear it is absolutely necessary for the beginner to fix upon a regular method of preparation in order that important parts may not be forgotten, or destroyed during the dissection.

The following is the method of dissecting given by Professor Lucae:—

I. Removal of the Temporal Bone with the whole Ear from the Skull. A small chisel is driven downwards transversely through the sella turcica between the processus clinoideus medior and anterior, and again a second time through the centre of the eminence of Blumenbach. Into the first opening a small Langenbeck's resection-saw is inserted perpendicularly, and the bone is then sawn outwards through the body, and greater wing of the sphenoid to the foramen rotundum of the sphenoid. The direction is then changed slightly backwards and outwards, and the cut continued through the

bone, parallel with the crista ossis petrosi, to the point where the squamous portion of the bone bends upwards. The saw is then to be inserted in the opening already made with the chisel in the eminence of Blumenbach and a cut made outwards and backwards, behind and parallel with the crista ossis petrosi, through the condyloid process of the occipital bone and for a part of the way in the lateral sinus, the cut ending at the spot where the lateral sinus turns backwards. These two cuts are then to be united by a third cut which should divide the crista ossis petrosi perpendicularly about one line behind the point of union of the posterior and middle third of the crista.

If it is desirable to remove both temporal bones the same procedure is to be carried out on the other side. If only one petrous bone is to be removed the two openings which were made with the chisel at the beginning are united by a medial cut, the loosened bone seized with forceps, raised up and dissected from the soft parts.

II. *Dissection of the Ear.* The anterior wall of the external meatus should be removed with scissors and gouge-forceps up to the membrana tympani. The osseous roof of the mastoid cells, of the tympanum and of the osseous Eustachian tube should then be chipped away with the gouge-forceps, or a small hook-shaped knife. The cartilaginous, muscular Eustachian tube should be opened from its pharyngeal orifice. For a thorough examination of the tympanum, including the ossicula, membrana tympani, tympanic muscles and nervus facialis, the mode of procedure is as follows: the tendon of the musculus tensor tympani and the articulation of the incus and stapes should be divided by a delicate knife; the pyramid should then be separated from the osseous structures surrounding the drum membrane and external meatus by sawing parallel with the crista ossis petrosi nearly but not quite into the tympanum; this cut should begin behind the styloid process and run along the anterior wall of the canalis caroticus. A light blow with a chisel in the cut thus made with the saw will now separate the portions of bone. The soft structures can then be dissected.

To examine the inner ear rapidly, saw along the whole length of the pyramid parallel with the crista ossis petrosi through the vertex of the upper semicircular canal; this cut runs along the posterior wall of the canalis caroticus. Draw out from the porus acusticus internus the facial and auditory nerves and examine the exposed coch-

lea and vestibule. For a more accurate examination of the inner ear remove the roof of the porus acusticus internus with the gouge-forceps, then open the vestibule from above by a small hand-trephine. After opening the osseous semicircular canals divide the membranous canals with scissors and remove from the vestibule the membranous utricle together with the membranous semicircular canals.¹ Expose the cochlea, which is bounded anteriorly and inwardly by the fundus of the porus acusticus internus, by gradually chipping away the bony mass surrounding it.

Besides the above method of Lucæ minute directions for dissection of the ear have been given by Toynbee,² Von Troeltsch,³ Voltolini,⁴ Wendt,⁵ and others which can be recommended to the beginner as standard procedures. The great difficulty of the dissection is first met in the inner ear, and can only be overcome here by great patience and practice. The membranous tissues of the labyrinth retain their structure much longer than is usually supposed ; in the preparation of these tissues a light yellow solution of potass chromate, or Müllers fluid, is recommended for their preservation. I recommend the following method of procedure as very well adapted to the examination of the inner ear : —

The trunk of the auditory nerve is followed to the point of subdivision by breaking away the meatus auditorius internus above it. In a microscopical examination of the nerve it is recommended that it be compared with other nerve trunks (facialis). The vestibule and cochlea should be opened from above by gradually chipping away the osseous roof with a chisel. The vestibule lies laterally

¹ See the method described in Virchow's *Archiv*, vol. xxix.

² Toynbee, *Diseases of the Ear*, p. 6.

³ Von Troeltsch, Virchow's *Archiv*, xiii., 513. *Lehrbuch der Ohrenheilkunde*, 6 Aufl., S. 587.

⁴ Voltolini, *Zerlegung und Untersuchung des Gehörorgans an der Leiche. Habilitationsschrift*, Breslau, 1862.

⁵ Wendt, *Archiv für Heilkunde von E. Wagner*, xiii., S 120.

from the facial nerve, that is, towards the squamous bone. Before reaching the vestibule the upper semicircular canal will be opened and the membranous canal should be cut through and drawn out. After laying open the vestibule the membranous labyrinth is exposed and should be removed with the other semicircular canals. As soon as the osseous roof of the cochlea is chiselled away the base of the modiolus, which lies towards the porus acusticus internus, should be broken off, and the whole cochlea with the spiral lamina lifted out. A careful dissection with needles is necessary for this. The contents of the cochlea thus removed should now be placed in a one per cent. solution of salt, aqueous humor, or perosmic acid, 0.1–1 per cent., and laid aside for microscopical examination.

There remains now only to examine the plate of the stapes and to expose the membrana tympani secundaria on its inner surface. The sawing open of the whole pars petrosa should be avoided if it is desirable to obtain a knowledge of the finer relations of the parts. The use of the saw is only allowable for the removal of the petrous bone from the skull, and should, as far as possible, be confined to this. The fret-saw for the removal of the bone from the base of the skull has the disadvantage that it is very easily broken, and its use requires great practice. Compass-saws are better adapted for the work, but the soft structures are too easily crushed by them. The most useful instruments are chisel and hammer, Lüer's gouge-forceps, and, for the finer work on the bone, a graver.

THE TEMPORAL BONE.

Malformations. In the peculiarities of formation in the temporal bone numerous individual differences exist, some of which are unimportant, while on some others it is possible that the fate of the individual may depend. They may form the foundation for a hereditary predisposition to certain diseases of the ear itself,¹ or also favor fatal secondary disease of the brain.

¹ From a hereditary unfavorable formation of the osseous middle ear, (Von Troeltsch). A slight depth of the niches of the labyrinthine fenestræ favors the retrogression of the swelling and duplicatures of the

A complete absence of the whole temporal bone is never found, but in some monsters a union of the two ears is seen, and in double monsters with a single head there may be a reduplication of the temporal bones.¹

In hydrocephalus the temporal bone is turned downwards and arched; the meatus is directed downwards.

Defects of certain parts from arrest of development are very common, on one or both sides. They may embrace all or only certain portions of the ear (most frequently the external and middle ear), while the other portions are well developed. With a well-formed external ear there may be arrest in the development of the inner ear and *vice versa*.²

Ossification Defects (rarefaction, opening) are among the most common inherited irregularities. They are especially frequent in the tegmen tympani³ with a perfectly normal dura mater, but are also found in the canalis caroticus, in the canalis facialis, in the floor of the tympanum, in the cortical substance of the processus mastoideus, in the osseous roof of the superior semicircular canal, and in the form of a fissure of the squamous portion of the bone; in elderly persons they are also seen in the form of pits

mucous membrane, while a greater depth of these niches, particularly of the fenestra ovalis, is unfavorable for this healing process.

¹ Carl Langer, *Zur Anatomie des Gehörorgans doppelteibiger Missgeburten*. Oesterr. Med. Wochenschrift, 1846, No. 21.

² The earlier observations on malformations of the temporal bone, up to the year 1837, are collected in Lincke's *Handbuch der Ohrenheilkunde*, i., 582-611. For the later literature see p. 28, under "Auricle."

³ Instead of absolute gaps in the bony tissue, the roof of the tympanum often contains cavities filled with reddish gelatinous tissue.

in the course of the fissura petroso-squamosa, and on the inner surface of the squamous bone, where they



Fig. 1.

Congenital Defect of the Bone on the upper surface of the pars petrosa near its apex, and also in the sigmoid sinus; otitis media purulenta acuta without perforation of the drum membrane, resulting in fatal basilar meningitis. *a.* Porus acusticus internus. *b, c.* Gaps in the upper surface of the petrous bone. *d.* Gaps in the sulcus transversus.

reach the size of a bean, and in their position correspond to the Pacchionian bodies. Aside from the possibility of mistaking these defects in ossification for carious destruction they have a great practical importance because they favor the extension of inflammatory processes from the ear to the brain.

Pneumaticity of the pars petrosa is understood to be the existence of anomalous cavities in the bone, which are filled with air or with a gelatinous red tissue. They surround the labyrinth on all sides, extending even to the upper wall of the meatus auditorius, and are in direct connection with the mastoid cells.

Hyperæmia of the petrous bone in which the tissue of the bone is very rich in blood, and when looked at through the dura mater often appears of a bluish red color, is very common in typhus, and is also seen in variola.

A general **atrophy** of the bone, in which it appears

abnormally light in weight and fragile, occurs in old age and with lues, tumors of the brain, and from other unknown causes (for instance, in connection with ankylosis of the stapes).

Osteoporosis occurs in old age and produces openings in the bone of the anterior wall of the meatus (Von Troeltsch).

Hyperostosis, in which the temporal bone appears very heavy and massive, its processes larger and fuller, its openings and capillary canals smaller and narrower than natural, is generally combined with a universal hyperostosis of the skull (syphilis, old age), but it may be confined to certain parts of the petrous bone, as the meatus externus, processus mastoideus, tuba Eustachii, canalis caroticus, and it is then frequently the result of continuous hyperæmia and long existing suppurative processes (with caries).

If the hyperostosis is the result of ossifying periostitis in foetal life or early childhood, it always leads to great deafness and deafmutism. The labyrinthine fenestræ are then found closed by ossification, the ossicula ankylosed into one mass, the labyrinthine cavities diminished in size, deposits of lime lie in the meatus internus and on the saccule of the vestibule, etc.

Friedreich¹ describes a hyperostosis of the petrous bone in a case of congenital unilateral hypertrophy of the head.

Caries and Necrosis.

Literature up to 1830 will be found in *Lehrbuch der Pathologischen Anatomie* von Otto. S. 174. — *Krukenberg*, *Jahrbücher der Ambulator. Klinik zu Halle*. Bd. II. S. 203–252. Halle, 1824. — *Wutzer*, *Schmidt's*

¹ *Virchow's Archiv*, 28, Heft 5 and 6.

Jahrb. 1834. S. 344. — *Bricheteau*, Arch. Gén. 1834. December. — *Willemier* (resp. Schröder van der Kolk), Diss. Inaug. Utrecht, 1835. — *Cruveilhier*, Anat. Patholog. du Corps Humain. 1835-1842. II. Vol. 33. Livraison. Maladies du Cerveau. — *Albers*, Ueber Otorrhoe, Gräfe's und Walther's Journal. 1836. — *Hamilton*, Dublin Journ. 1841. — *Hughes*, Lancet. 1841. — *Smith*, Dublin Journ. 1841. — *Guckelberger*, Zeitschr. f. Chir. und Geburtsk. VII. 3. 1854. — *Wolf*, Preuss. Vereins-Ztg. 1857. Nos. 35, 36. — *Menière*, Article on Bony Sequestra observed in the different Parts of the Ear. Gaz. Med. de Paris. 1857. No. 33. — *Hutchinson*, Canstatt's Jahresber. 1861. 3. S. 50. — *J. Gruber*, Wien. Med. Halle. 1863. — *Odenius*, Medicinske Arch. III. 1. 1866. — *Von Troeltsch*, Anat. Beiträge zur Lehre von der Ohrenerkung. Arch. f. O. IV. S. 97-142.

1869. — *J. Gruber*, Zur Casuistik der Schläfenbein-Necrose. M. f. O. 1874. No. 9. (Case of loss of the whole annulus tympanicus and a portion of the squama through the external meatus, in a child two years old.) — *Boeters*, Necrose des Gehörlabyrinths. Diss. Inaug. Halle, 1875. — Also the already quoted text books of otology and the special journals.



Fig. 2.

Carious Perforation of the Anterior Wall of the Pyramid at the spot where the pars petrosa of the temporal bone passes into the pars squamosa. Corresponding with this spot on the lower surface of the dura mater were masses of granulations, the upper surface of the dura mater being unchanged. Death from pyæmia. For history and dissection, see Archiv für Ohrenheilk., II., S. 36.

Caries, or ulcerative ostitis, attacks, of all the bones of the skull, the temporal bone most frequently; it is very often bilateral and associated with simultaneous caries of other bones of the skull.

The points of preference for caries are the mastoid process, the median portion of the upper posterior wall

of the meatus (floor of the antrum mastoideum), and the walls of the tympanum, preferably its roof; less frequently the pars petrosa is attacked and least frequently the meatus auditorius internus. Exceptionally extensive caries can exist in the petrous bone,



Fig. 3.

Caries Necrotica. In the carious cavity *a*, is a loose sequestrum, consisting of the greater part of the pyramid. *b*. Nervus acusticus. *c*. Processus condyloideus of the lower jaw. *d*. Dura mater, with granulation-growths upon it, turned back.

tympanum, tuba, mastoid process, and even in the external meatus, and yet the membrana tympani remain entire, and the ossicles continue in their position.¹ Usually, however, the drum-membrane shows a loss of substance or is wholly destroyed. The dura mater covering the bone is generally thick-

¹ Already proven by old observations: Lieutard, *Hist. Anat. Med.*, vol. ii., lib. iii., observ. 108. Kuh, *Klinische Beiträge*, etc., Fall 2, S. 20.

ened, is frequently but slightly attached to the bone and discolored; on removing it granulations are found attached to its inner surface, which fill up the carious openings in the osseous substance.

The caries is generally the secondary result of an acute or chronic suppuration of the soft tissues of the ear, which has extended to the surrounding bone; seldom is it the result of suppurative otitis or primary periostitis. Usually the ulcerative process extends from the surface deeper and deeper into the substance of the bone. Frequently on dissection processes of demarcation are seen, osteosclerosis or osteophytes.

Necrosis is less common than caries; it attacks most frequently the mastoid process, the lower wall of the external meatus, the ossicula and the pyramid. Sometimes the squamous portion of the bone is alone attacked by necrosis and may be thrown off in toto. Cases have even been reported where almost the whole temporal bone has been thrown off by necrosis with retention of life.

The most common fatal results from these processes are purulent meningitis,¹ abscess of the brain,² sinus-phlebitis with pyæmia,³ or combinations of these dis-

¹ Guckelberger, l. c. Hinton, *Med.-Chir. Transactions*, xxxix., p. 101, 1856. Von Troeltsch, *Virchow's Archiv*, xvii., S. 14. Voltolini, *Ibid.*, xviii., S. 2. Ulmer, *Wiener Med. Halle*, 1861, S. 40, 41. Ockel, *Petersburger Med. Zeitschrift*, 1862. Wendt, *Archiv. für Phys. Heilkunde von Wagner*, 1870, etc.

² Lebert, *Virchow's Archiv*, x. Von Troeltsch, *Ibid.*, xvii., S. 42. Gull, *Guy's Hospital Reports*, 1858. Gruber, *Zeitschr. der Wiener Aertze*, 1860. Schott, *Würzb. Med. Zeitschr.*, 1861, S. 462. R. Meyer, *Pathologie des Gehirnbräuses*, Zürich, 1867; eighteen cases following caries of the petrous bone, fourteen on the right, four on the left side. Wendt, l. c., etc.

³ Lallemand, *Lettres*, iv. § 36. Bruce, *London Med. Gaz.*, vol. xxvii.,

eases. Much less common are fatal hemorrhages from carious perforation of the canalis caroticus with erosion of the carotis cerebialis,¹ of the arteria meningea



Fig. 4.

Necrosis of the Pyramid. *a.* Sinus transversus. *b.* Nervus acusticus. *c.* Sequestrum slightly movable on firm pressure. *d.* Probe in an opening of the labyrinthine cavity. *e.* Apex of the pyramid. Death from abscess in the cerebellum.

p. 608 (an admirable article). Sédillot, *De l'Infection Purulente*, 1848. Toynbee, *Med.-Chir. Transactions*, 1851, vol. xxxiv. Lebert, *Ueber Entzündung der Hirnsinus*. *Virchow's Arch.*, ix., 1855. Heussy, Zürich, 1855. Weill, Strassburg, 1858. Von Dusch, *Zeitschr. f. Rat. Med.*, 1859. Cohn, *Klinik der Embolischen Gefässkrankheiten*. Berlin, 1860. Von Troeltsch, *Virchow's Arch.*, xvii., 1, 2. Gruber, *Wiener Wochenbl.*, 1862, Nos. 24, 25. Lancereaux, *De la Thrombose et de l'Embolie Cerebrale*, Paris, 1862. Griesinger, *Arch. für Phys. Heilkunde*, 1862. Schwartz, *A. f. O.*, vi., S. 219. Politzer, *Ibid.*, viii., S. 288. O. Heubner, *Arch. für Phys. Heilkunde*, ix., 1868. Wreden, *Petersb. Med. Zeitschr.*, xvi., 5, S. 61-137. Wendt, *Arch. für Heilkunde von Wagner*, xi., S. 562.

¹ Kimmel, *Observatio Anat. Patholog. de Canali Carotico Carie Syphilitica Exeso*, Lipsiæ, 1805, with an illustration. Boinet, *Arch. de Méd.*, 1837. Lavacherie, *Bulletin de l'Acad. de Méd.*, 1848, vol. vii., p. 789. San-

media, of the large venous sinuses or of the bulbus venæ jugularis.

By which channels the extension of the purulent inflammation takes place frequently remains uncertain at the autopsy; in many cases it probably takes place along the course of the veins (aquæductus vestibuli and cochleæ), along the folds of the dura mater which

extend into the fissurâ petroso-squamosa, along the neurilemma of the acusticus or facialis, and also along the connective tissue of the capillary blood-vessels which perforate the bone in all directions (tegmen tympani, hiatus sub-arcuatus).



Fig. 5.

Caries of the Sulcus Transversus produced by a very extensive caries of the mastoid process. The sinus transversus was very much thinned, but without ulceration. (From Toynbee, "Diseases of the Ear," p. 327.)

Sometimes death results from severe brain symptoms, where it is impossible to find anything more pathological in the

brain than œdema, the causal connection of which with the ear-disease is perhaps very improbable.

tesson, *Hygiea*, Bd. xiv., 1855. Chassaignac, *Traité de la Suppuration*, vol. i., p. 529. *Gaz. des Hôp.*, 1857, p. 226. Marc Sée, *Bullet. de la Soc. Anat. de Paris*, 1858, p. 6. Toynbee, *Med.-Chir. Transactions*, xliiii., p. 217 to 224, 1861. Baizeau, *Gaz. des Hôp.*, 1861, p. 350. *Tödliche Ohrblutung bei Syphil. Caries*, *Deutsche Klinik*, 1863, No. 23. Boeke, *Pesth. Med. Chirurg. Presse*, x., 28. A. Hermann, *Wien. Med. Wochenschrift*, xvii., 30-32. Pilz (Billroth), *Diss. Inaug.*, Berlin, 1865. Broca, *Gaz. des Hôp.*, 1866, No. 53, p. 240. Hynes, *The Lancet*, 1870, No. 13. Jolly, *Arch. Génér. de Méd.*, 1870, March.

Of late years the views of the relations of caries to abscess of the brain have been decidedly modified. Formerly it was generally thought that the brain-abscess was the primary lesion, and that the pus sought an exit for itself through the cavum tympani;¹ and it was considered to be the rule only in very exceptional cases that the caries of the ear was the primary, and the abscess of the brain the secondary lesion; to-day, however, it is almost universally considered that the facts are just the reverse.

The first who asserted this with confidence was Morgagni.² He declared, that in the majority of cases the brain affection was only the result of the caries extending into the cavity of the skull. The opposite process, a suppuration within the skull making an outlet for itself through the ear, although it may perhaps occur, is certainly very rare.

Only a few authors, as Odenius,³ now hold to the correctness of the old theory for exceptional cases. The possibility of an abscess in the cerebrum or cerebellum discharging itself through the temporal bone (otorrhœa cerebrealis, Itard), cannot certainly be de-

¹ Otto, *Seltene Beobachtungen*, etc., ii., S. 97, says: "The abscess, which I have always found only in the middle cerebral lobe and never in the cerebellum, lies at the lowest point of the whole brain, and the pus must therefore, from the law of gravity, sink and work its way through the bone."

This theory of an opening of a brain abscess into the tympanic cavity from destruction of its roof or of the mastoid cells, is found even in Rokitsky, 3 Aufl., Band 1, 2, S. 460, 1855.

² l. c., I., ep. xiv., art. 6.

³ The case quoted by Odenius in support of his theory is as follows: After injury to the head an abscess in the right cerebellum with pachymeningitis; on the pars petrosa there was a superficial ulceration at the external opening of the aquæductus vestibuli while the inner ear showed only very slight signs of disease. *Medicinske Archiv*, iii., i., No. 4.

nied, since abscesses of the brain sometimes seek an outlet for the pus in other parts of the skull through natural or fistulous openings (ethmoid, frontal, sphenoid, and parietal). The assertion of Lallemand that the pus of a brain-abscess never seeks an outlet at any other spot than the ear, is incorrect. The facts are that, as a rule, the abscess of the brain is secondary and the result of suppuration in the ear produced by an inflammation of the veins. It should not be forgotten, however, that abscess of the brain and disease of the ear may occur simultaneously from the same cause (trauma), as has already been shown by Albers. Abscesses of the brain from otitis are situated in the temporal lobes of the cerebrum or in the cerebellum, more frequently on the right side.

Heusinger¹ found in one case double abscess in the posterior lobe of the cerebrum and in the cerebellum with thrombus of the right lateral sinus, the development of which had been unsuspected. Abscess of the brain frequently occurs without being in direct connection with the carious mass.

Von Troeltsch and Magnus,² each in one case, found an abscess of the brain on the opposite side from the affected ear. In such cases it has been supposed by some that the abscess was caused by metastasis (embolus) from the carious spot; while by others all connection between the abscess and the caries has been denied, and tuberculosis of the lungs was regarded as the cause of the brain-abscess (infection of the brain from a gangrenous cavity). Finally, the possibility of the accidental coincidence of the very frequent

¹ *Virchow's Arch.*, xi., S. 92.

² *A. f. O.*, xi., S. 293.

caries of the temporal bone with an idiopathic abscess of the brain has been accepted by others, as was long since suggested by Abercrombie.

Exceptionally cases occur where instead of an abscess a tumor of the brain¹ is found with chronic otitis.

Both dissection and frequent clinical experience show that caries of the temporal bone often heals. If the labyrinth is exempt from the caries loss of the hearing may not occur, but a very considerable degree of the hearing may remain, depending on the extent and location of the carious destruction.

Fractures of the base of the skull often reach the temporal bone and allow a discharge of the liquor cerebro-spinalis if they have extended into the labyrinth or the porus acusticus internus, into which the subarachnoid cavity enters with the dura mater and arachnoid. A rupture of the membrana tympani and bleeding from the ear is usually associated with such a fracture, but not always. In the latter case the cerebro-spinal fluid may ooze out through a fissure of the osseous canal. Sometimes the fissure extends through both petrous bones, even when the injury has taken place only on one side of the head.² The injuries which are found on careful preparation of the petrous bone are naturally very variable. Wendt, for example, found in one case not only fracture of the base of the stapes and the bridge of bone lying between the oval and round fenestræ, but also brain substance in the vestibule and tympanum. It is

¹ Bright, *Guy's Hospital Reports*, ii., 1857. p. 279, 2 cases. Fischer, (case from Traube's Clinic), *Charité-Annalen*, 1863.

² Case by Voltolini, *M. f. O.*, 1869, S. 110.

well known that brain substance may be forced out through the meatus.

The usual result of fractures of the petrous bones is death from inflammation of the brain and its membranes which may only develop several weeks after the injury. If the reactive inflammation is not fatal total deafness remains. If inflammation of the meninges does not occur the fracture may heal, seldom by osseous consolidation but more frequently by fibrous union. This possibility has been confirmed by trustworthy dissections.¹

New Growths. *Exostoses* arising from the temporal bone and projecting into the cavity of the skull have been described by several authors, Petit, Cruveilhier,² Toynbee.³

R. Volkmann⁴ has figured one of immense size from the pathologico-anatomical museum in Halle; it existed simultaneously with sclerotic thickening of the bones of the skull.

Smaller exostoses within the cavities of the ear are common; they are most frequent in the meatus ex-

¹ See Langenbeck's *Archiv*, vi., S. 576. Deafness and facial paralysis on the left from a fall on the left side of the occiput. Recovery. Death from tuberculosis seven months afterwards. Anatomical appearances: on the base of the skull, corresponding to a fissure at that spot, a yellowish, rusty-brown discoloration; a new growth of connective tissue in the brain; the origin of the nervus acusticus sinister in the fourth ventricle less white than on the right side and infiltrated with numerous corpora amylacea; the nerve fibres of the trunk of the acusticus normal. The fissure of the skull passed through the pars tympanica, through the porus acusticus externus, and separated the mastoid and squamous from the petrous portion of the temporal bone. *The gap in the bone was partially filled by fibrous tissue, partially by a mass of bone.*

² *Anat. Patholog.*, ii. Livraison, xxvi.

³ Catalogue, No. 791.

⁴ *Knochenkrankheiten*, S. 429.

ternus, where they may lead to complete closure of the canal.

The condition which has been particularly described by French authors as tubercle or tubercular infiltration¹ of the petrous bone, and has been assumed to be a frequent cause of chronic otitis and caries in phthisical persons, corresponds to our present idea of otitis caseosa. The masses which are described as tubercles are carious cavities in the bone which are filled with inspissated pus. Real tubercles in the petrous bone are very rarely seen; they do, however, exist and have recently been described by Zaufal.²

A tubercular mass of the size of a pigeon's egg, which I once found on the porus acusticus internus, did not arise from the petrous bone but from the dura mater.

In pigs primary tuberculosis of the temporal bones occurs not unfrequently.³

Cholesteatoma.

Virchow, *Virch. Arch.*, VIII. S. 371. — *Toynbee*, *Lond. Med. Gaz.* 1850. Nov. *Med.-Chirur. Transactions*. Vol. xlv. VII. Series. Diseases of the Ear. 1860. — *Gruber*, *Allgem. Wien. Med. Ztg.* 1862. Nos. 31, 33. — *H. Fischer*, *Charité-Annalen*. 1865. XIII. S. 262. — *Prahl*, *Diss. Inaug.* Berlin, 1865. — *Batemann*, *On Cholesteatoma*. *Arch. of Med.* Vol. IV. 1866. — *Von Troeltsch*, *A. f. O.* IV. S. 99, 103, 106, 112, 118, 127, and *Lehrbuch*. 6 Aufl. S. 461. — *Buhl* (Nobiling), *Bayr. Aerztl. Intelligenzblatt*. 1869. No. 33. Fall 4. — *Lucæ*, *Verhandl. der Berl. Med. Gesellsch.* I. (Sitzung vom 26 Febr. 1873) and *Arch. für O.* VII. S. 254. — *Wendt*, *Arch. f. Phys. Heilkunde von Wagner*. XIV. 1873. — *Sitzungsprotocoll der Section für Ohrenheilkunde auf der Naturforschervers. in Leipzig*. 1873. (Siehe *Arch. f. O.* VIII. S. 215.)

¹ Rilliet and Barthez, *Traité des Malad. des Enfants*, Bruxelles, ii., p. 489. Nélaton, *Recherches sur l'Affect. Tuberc. des Os*, Paris, 1837, pp. 46, 70. Grisolles, *Presse Méd.*, 1837, No. 32.

² *A. f. O.*, ii., S. 174.

³ Schütz, *Virchow's Arch.*, Band 66, S. 93.

Cholesteatoma of the temporal bone (pearl tumor, Virchow; molluscous or sebaceous tumor, Toynbee) is a name often used for various pathological conditions. In some of the least common cases it designates a true new growth arising from the bone, or from parts of the ear (skin of the meatus externus,¹ membrana tympani,² or mucous membrane of the tympanum³)



Fig. 6.

Circumscribed Atrophy from a Cholesteatoma. *a.* A large opening in the posterior wall of the meatus leading into a closed cavity, of the size of a walnut, in the pars mastoidea, with perfectly smooth and solid walls. *b.* Entrance to the tympanum. At the sinus lateralis is a thin, transparent spot of bone. The corresponding temporal bone on the right side was perfectly normal.

analogous to the cholesteatoma of other bones of the skull (occiput, os frontis), brain, or meninges. It

¹ Toynbee, *Sebaceous Tumors in the Ext. Auditory Meatus*. *Med.-Chirur. Transact.*, vol. xlv. Schwartz, *A. f. O.*, vi., S. 294; *Ibid.*, vii., 259, Note.

² Hinton, *A. f. O.*, ii., S. 151. Wendt, *A. f. Heilk.*, xiv., Heft 6. Küpper, *A. f. O.*, xi., p. 18.

³ J. Gruber (*l. c.*).

consists of a thin fibrous capsule, which contains a substance resembling stearine, and glistening like mother-of-pearl, the morphological elements of which are chiefly flat cells of polygonal shape (epidermal cells), and also often, but not constantly, crystals of cholesterine in small numbers. (According to Lucae, they contain also nucleated giant cells.)¹

In those cases in which a true new growth exists, all inflammatory irritation in the neighborhood is wanting in the earlier stages of its development, and supuration with a destructive tendency is only shown later, when we may have perforation of the membrana tympani, or the bone of the upper wall of the meatus, or of the sulcus transversus, with opening into the middle or posterior fossa of the skull.



Fig. 7.

Circumscribed Atrophy of the Sulcus Transversus from cholesteatoma, with erosion of the sinus (otorrhagia). Antrum mastoideum and tympanum with smooth walls, and much enlarged by atrophy from pressure. The opening into the sulcus measures 11 mm. in length and 5-6 mm. in breadth, and has perfectly smooth edges.

That cholesteatoma may appear as a true new growth in the middle ear, has been lately fully established on dissection by Lucae,² as he found with the growth neither inflammation of the tympanum nor perforation of the membrana tympani.

¹ R. Volkmann, *Knochenkrankheiten*, S. 487, places the cholesteatoma midway between cancrioid and atheroma.

² *l. c.*

In the great majority of cases of so-called cholesteatoma in the temporal bone, we are dealing with nothing more than a retention of inflammatory products, the result of suppurative processes (Von Troeltsch). A collection of concentric layers of epidermis cells and occasional masses of cholesterine crystals form around a nucleus of fatty and caseous pus; the connective tissue capsule is wholly wanting. The cause of these collections is purulent catarrh of the middle ear, with polypoid granulations and perforation of the membrana tympani.

Such collections are found in the natural cavities,

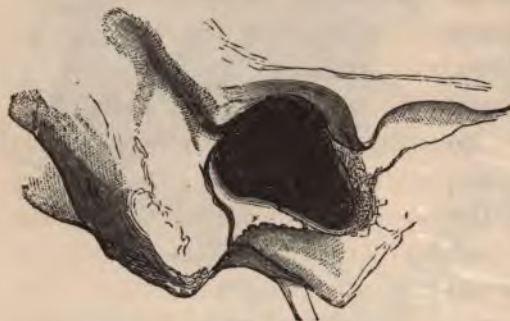


Fig. 8.

Circumscribed Atrophy of the External Meatus, from cholesteatoma.

most frequently in the antrum mastoid-deum; but they may exist in the tympanum, meatus externus, or in the cavities of the temporal bone which have

been enlarged or freshly excavated by the pressure of the mass. In this way the whole temporal bone may be infiltrated and destroyed. By pressure on the neighboring tissues, from the increase in the collection and from its swelling by absorption of moisture, or by the retention and resorption of the degenerated products of secretion, serious diseases, and even death may result (purulent sinus-thrombosis with pyæmia, meningitis, abscess of the brain).

From time to time parts of the retention-tumor may become loosened and be thrown off; this is usually preceded by severe pain caused by the swelling of the mass.

The flat polygonal cells, which generally constitute the chief part of these masses and of the whole tumor, very much exceed in size the normal pavement epithelium of the tympanic mucous membrane, being three times and more larger (0.02–0.03 mm. in diameter), and exactly resemble the cells of the epidermis. Their apparent want of nuclei is not real, as the nuclei can be brought out clearly by treatment with ammoniated solution of carmine (Lucae). Between the cells grains of fat are very frequently seen, and sometimes threads of fungus.

The source of these large flat cells has been often discussed. Lucae considers that the epidermis cells have their origin on the granulations, the older layers being continually thrown off and gradually collecting in the cavity of the middle ear. On this account he considers that the removal of the granulations is the chief point of therapeutics. Von Troeltsch has sometimes found these gigantic flat cells in the normal covering of the antrum mastoideum, most commonly, however, with collections of pus in this cavity, and he therefore thinks it very possible that under pathological irritation and pressure this epithelial surface develops in some special way.¹ The fact is, that the tympanic epithelium, under a chronic purulent inflammation with defect of the drum-membrane, often assumes the characteristics of the skin, showing a rete Malpighii and epidermis.

¹ *Lehrbuch*, S. 425.

Wendt considers that the development of the so-called cholesteatoma of the temporal bone is due to a form of *desquamative inflammation of the mucous membrane of the middle ear* (with or without perforation of the membrana tympani), the epithelium of this mucous membrane assuming an epidermal character, and developing a rete Malpighii during or after a chronic inflammatory process. Chronic inflammation of the walls of the meatus may lead to the formation of a cholesteatoma, if the exfoliated masses get into the middle ear, either through a perforation of the drum-membrane, or through an opening in the osseous walls of the meatus.

Malignant Tumors of the temporal bone are not common, if those cases are excluded in which tumors of neighboring parts (parotid gland, base of the skull, antrum of Highmore, etc.) have led to secondary destruction in the ear. I myself have seen three cases of primary epithelial cancer of the temporal bone, of which two have been reported, and in all of them the origin of the growth was the tympanic mucous membrane.¹

Fig. 9 shows the extent of the destruction of the bone in one of these cases, seen from the inside.

A list of all the malignant tumors known to me is confined to five cases described by Toynbee² (carcinoma), one by Gerhard³ (carcinoma of the left petrous bone), one by Billroth⁴ (without autopsy), two by Wilde⁵ (osteosarcoma), one by Travers⁶ (without

¹ *Archiv f. Ohrenheilkunde*, ix., S. 208, 215, Note.

² *Diseases of the Ear*, chap. xvii.

³ *Jenaer Zeitschr.*, i., 4.

⁴ *Arch. f. Klin. Chir.*, x., S. 67. Compare also *A. f. O.*, v., S. 28.

⁵ *Pract. Bemerkungen*, etc., S. 244.

⁶ *Froriep's Notizen*, Bd. 25, No. 22, S. 352.

autopsy), one by Boeke,¹ one by Wishart,² one by Robertson³ (sarcoma). To these may be added three cases by Cruveilhier;⁴ two of these, although described under the name "tumeurs fibreuses du



Fig. 9.

Destruction of the Temporal Bone by Epithelial Cancer. *a.* Median remnant of the pars petrosa; on the superior surface of its apex the bone is also destroyed by the new growth. *b.* Porus acusticus internus. *c.* Foramen lacerum anterius. *d.* Foramen ovale, enlarged by destruction of its edges to twice its natural circumference. *e.* Foramen spinosum. *f.* Sphenoid articulation.

rocher," Rokitsky considers should probably be regarded as cancer, although in the first case, which is the most fully described and figured, Cruveilhier expressly adds, "ne presentait pas le moindre

¹ *Wiener Med. Halle*, 1863, Nos. 45, 46.

² *Edinb. Med. and Surg. Journ.*, xviii., p. 393.

³ *Transactions of the American Otological Society*, 1870.

⁴ *Anatomie Pathologique du Corps Humain*, ii., xxvi., planche 2.

vestige de dégénération cancéreuse." From a remark of Cruveilhier's, it seems to be implied, that he had frequently found tumors originating from the posterior and anterior surfaces of the petrous bone. "Ces tumeurs sont tantôt fibreuses, tantôt osteo-fibreuses: d'autres fois, elles présentent la dégénération cancéreuse dans une



Fig. 10.

Destruction of the Petrous Bone by a Fibrous Tumor, from Cruveilhier. The tumor originated apparently from the extension of the dura mater into the porus acusticus internus. The openings in the bone involve the inner half of the posterior surface of the pars petrosa, communicate extensively with the canalis caroticus, and unite the meatus auditorius internus, which cannot be recognized, with the foramen lacerum posterius.

partie de leur étendue. La description des tumeurs du rocher mériterait de trouver place dans l'histoire des tumeurs développées dans le crâne," etc. Death generally results from marasmus or pressure on the brain, sometimes from basilar meningitis.

AURICLE.

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der Ohrmuschel mit Fehlen des Gehörgangs. Beiträge, etc., Leipzig, 1846. S. 1 u. 2. — *A. Thompson*, Edinburgh Journ. of Med. Science, April, 1847. — *Birnbaum*, Diss. Inaug. Giessen, 1848. — *Wallmann*, Ueber Missbildungen des Knöchernen Gehörorgans. Virch. Arch. 1857. VI. S. 603. — *Stahl*, Einige Skizzen über Missstaltungen des äusseren Ohres. Allgem. Zeitschrift für Psychiatrie. XVI. S. 479. 1859. — *Toynbee*, Diseases of the Ear. 1860. S. 15. — *M. Schultze*, Missbildungen im Bereiche des ersten Kiemenbogens. Virch. Arch. XX. S. 378. — *Heusinger*, Ueber Halskiemenfisteln von noch nicht beobachteter Form. Virch. Arch. — *Betz*, Ueber Fistula Auris Congenita, Memorabilien. VIII. 24 June, 1863. — *Bauer*, Ueber die Felsenbeine der Hemicephalen. Diss. Inaug. Marburg, 1863. — *Claudius*, Ueber den Schädel der Hemicephalen. Zeitschr. f. Rat. Med. XXI. 2. 1864. — *Kollmann*, Beiträge zur Entwicklungsge-
schichte des Menschen. Zeitschr. für Biologie. IV. S. 260 u. Taf. VII. — *Lucae*, Virch. Arch. XXIX. S. 62 and A. f. O. X. S. 238. — *Heusinger*, Virch. Arch. XXIX. S. 361. — *Virchow*, Ibid. XXX. S. 221 and XXXII. S. 518. — *Voltolini*, M. f. O. II. No. 1. 1866. *Flechtinger*, Allgem. Wiener Med. Ztg. 1866. No. 16. — *Wreden*, Petersb. Med. Zeitschr. XIII. S. 204. 1867. — *Heusinger*, Deutsche Zeitschrift für Thiermedizin und Vergleichende Pathologie. II. 1870. — *Gruber*, Lehrbuch. 1870. S. 276. — *Schmitz*, Ueber Fistula Auris Congenita und andere Missbildungen des Ohres. Diss. Inaug. 1873. Halle.



Fig. 11.



Fig. 12.

Bilateral Cats-ears with stenosis of the meatus and congenital deafness. Unilateral atrophy of the face.

Malformations. Complete absence from arrest of development may be found on one or both sides. Absence of certain parts (lobule, helix, antihelix, car-

tilage), and imperfect development of the auricle (microtia) of various kinds is much more common. Sometimes the auricle appears pressed together from



Fig. 13.



Fig. 14.



Fig. 15.



Fig. 16.

Cats-ear on the left dislocated downwards; on the right abnormal hypertrophy of the auricle. Unilateral atrophy of the face.

FIG. 16. Bilateral Malformation of the Auricle with atresia of the meatus. Deaf-mutism.

above downwards, the cats-ear as seen in the old statues of Pan (Figs. 11, 12, 13, 14, 15); sometimes spindle-shaped (Figs. 16, 17), and with deep indentations, or even with horizontal fissures. The tragus

may be so turned inwards as to close the meatus; in Fig. 18 only the fissured lobule was present, below which was the entrance into a meatus extremely con-



Fig. 17.



Fig. 18.

FIG. 17. Unilateral Deformity of the Auricle with Atresia of the Meatus.

FIG. 18. Microtia with Stenosis of the Meatus. Only a fissured lobule remains. Unilateral atrophy of the face.

tracted and directed upwards, the end of this meatus being closed as in the normal ear by the membrana tympani. Posteriorly from this rudimentary auricle the dislocated cartilage could be felt under the skin.

The lobule is frequently adherent to the skin; the upper edge of the auricle is rarely so attached.

Usually with deformity of the auricle, such as is represented in Figures 19, 20, 21, 22, further malformations exist in the deeper parts of the ear, atresia, stenosis or complete absence of the meatus, or even of the labyrinth. Exceptionally the other parts of the ear may be normally formed.

Stenosis, or atresia of the meatus externus, is specially frequent. According to Virchow¹ congenital anomalies in the external ear and its neighborhood are to be referred to early disturbances in the closure

¹ *Virchow's Archiv*, Bd. 30, S. 221, and Bd. 32, S. 518.

of the first branchial cleft, and are often associated with fistulæ of the other branchial clefts, cleft palate and other forms of arrest of development in the facial bones, as, for instance, with unilateral atrophy of the face (Figures 12, 13, and 18). Stahl had already di-



Fig. 19.



Fig. 20.

FIG. 19. Deformed Auricle with Absence of the Meatus. The cartilage undeveloped, only seven lines long, and with three small ill-defined depressions. Lobulus as large as that of the healthy ear. Helix scarcely perceptible, tragus, antitragus, antihelix, concha and fossa navicularis wanting. (From Michael Yaeger in Von Ammon's "Zeitschr. f. Ophth.," Bd. V., H. I.)

FIG. 20. Deformity of the Auricle with Atresia of the Meatus. The ear is very small; the posterior edge of the helix is turned forwards (*d*); only slight traces of the antihelix (*e*) and its fossa; the tragus (*f*) turned backwards and felt through the skin as a cartilaginous point. From the tragus a cartilaginous half-ring could be felt running downwards and forwards which, according to Yaeger, was a trace of the cartilaginous meatus. Opposite the tragus was a point of the antitragus (*g*) and behind this two blind fossæ. The cartilage proper is wanting; the lobule is united with the skin at its posterior edge and lower end; the helix the same; at the unattached spot a pouch-like depression two lines long and the same broad existed. (From Michael Yaeger.)

rected attention to the fact that deformity of the auricular cartilage might be regarded as an indication of imperfect development of the rest of the skull, and that it bore a semeiotic relationship to the development of the skull.

Rudimentary auricles are not usually inserted in the normal position. It may, however, also happen that well-formed auricles are dislocated on to the cheek, neck, or shoulder.

A by no means rare form of arrest of development is the fistula auris congenita, first described by Heusinger, which is to be regarded as a remnant of the first branchial cleft. The fistulous opening generally lies in front of the ear, usually one centimeter above



Fig. 21.

Congenital Deformity of the Auricle.
(From J. Gruber, "Lehrbuch," S. 275.)



Fig. 22.

Microtia (From J. Gruber, "Lehrbuch," S. 275.)

the tragus, but sometimes it is in the lobule (Betz). A portion of the fistulous canal can sometimes be followed with a very fine probe or bristle, or its callous walls can be felt between the auricular cartilage and the skin. From its opening a whitish yellow, cream-like fluid exudes, which contains numerous pus cells. By closure of the fistula small tumors produced by the retention of the secretion may form in front of the tragus. On the same spot in the skin in front of the meatus very small cicatricial depressions are

often seen which are also to be referred to anomalies in the closure of the first branchial cleft. These fistulæ exist with or without malformation of the auricle; sometimes they are associated with fistulæ of the neck. Communication with the middle ear or pharynx could not be found in the cases which I have observed.

Excessive development is seen as (1) abnormal enlargement, complete or



Fig. 23.

Auricular Appendages, Polyotia; three wart-like appendages in front of the ear. (From Von Ammon, Table xxxiii. Fig. 16.)

partial (Figures 13 and 15, right ear); (2) auricular appendages (polyotia) which may be said to duplicate certain parts of the auricular cartilage. Under the skin a misplaced bit of cartilage can be felt. These appendages, according to Virchow, consist of skin, subcutaneous cellular tissue, and reticular cartilage; they are seldom numerous, are most common in front of the tragus, but may be situated on the lobule or side of the neck.

(3) Reduplication. Langer found four lobules in two cases of monstrosities with double bodies.¹ Wilde describes a case from Cassebohm of a child with two ears in the usual situation and two below on the neck.

¹ *l. c.*

The form, size, position, and angle of insertion of the auricle is subject to very great individual variations. Irregularities in the formation of the helix are very common. Darwin assigns a so-called pointed ear, *i. e.*, an ear with a sharply defined indentation of the helix, as is constantly seen in old statues of satyrs and centaurs, to the earliest orders of human beings.

Othæmatoma (blood-tumor, hæmatoma auriculæ, perichondritis auricularis, erysipelas auriculæ.¹)

Bird, Journ. v. Gräfe und Walther. 1833. XIX. S. 631. — *Saxe*, De Othæmatomate Vesanorum Commentatio. Diss. Inaug. Leipzig, 1853, with the literature up to 1852. — *R. Hofmann*, Oesterr. Zeitschr. für pract. Heilkunde. 1862. No. 33. — *G. Haase* (Henle's und Pfeuffer's Zeitschr. III. Reihe. Bd. 24. S. 82. 1865). A complete catalogue of the literature, 1833–1864. — *Virchow*, Geschwülste. I. S. 135. — *L. Meyer*, Virchow's Archiv. XXXVII. Heft 4. — *Gudden* (Zeitschr. für Psychiatrie. XVIII.). — *Griesinger*. — *Parreidt*, Diss. Inaug. 1864. Halle. — *Haupt*, Diss. Inaug. 1867. Würzburg.

This is a fluctuating tumor on the concavity of the auricle formed by a discharge of blood between the perichondrium and cartilage. The perichondrium is not only separated by the effusion from the cartilage, but bits of the cartilage usually remain attached to the membrane. In fresh cases it comes on with inflammatory symptoms, most frequently during dementia paralytica, but it may occur in persons of sound mind; it is by no means always of a traumatic nature. A predisposition to it is shown by a disease of the cartilage which shows spots of softening and spaces filled with fluid.

The hæmorrhage is generally resorbed and the thickened perichondrium is again attached to the cartilage, but a permanent deformity is left from the

¹ Compare Kleb's *Pathologische Anatomie*, Bd. I., S. 98.

thickening and cicatricial shrinking of the auricle. Suppuration and spontaneous rupture are very rare and only occur in traumatic othæmatoma. Calcification of the cartilage is common as a result of the effusion.

Inflammations and their Results. The usual diseases of the skin may be located on the auricle. Erythema (as intertrigo behind the ears), eczema, erysipelas, are very common, phlegmonous inflammation, gangrene



Fig. 24.

Nævus of the Auricle. Removed with the knife by Prof. R. Volkman, after the application of a ligature. Recovery.

(in typhus, measles, erysipelas, or spontaneously in nurslings), are less common. Lupus, pemphigus syphiliticus, and ichthyosis congenita, are also seen on the auricle. Spontaneous perichondritis resulting in abscess, has been in rare cases observed on the auricle and heals usually without leaving a deformity. Partial calcifications and very rarely ossifications,¹ the

¹ Bochdalek, *Prag. Vierteljahrsschr.*, 1865, i., S. 33. *Otologische Beiträge.*

result of defective nutrition alone without a sign of appreciable irritation, may be seen on the auricle; concretions of urate of soda are also found in arthritic persons (Garrod). The auricle is almost completely exempt from syphilis, and fractures are very rare on account of its elasticity. After burns and skin eruptions synechiæ, or adhesions of the auricle at its posterior surface to the skull, may occur.

New Growths.

Fischer, Comment. de Cancro Auris Humanæ. Lüneburg, 1804. Habilitationsschrift. — *Mitteldorpf*, Galvanocaustik. 1854. S. 111. — *Wilde*, Practical Observations, etc. 1855. p. 193. — *Von Bruns*, Handbuch der Pract. Chirurg. 1859. Abth. II. S. 135, Abth. II. S. 167. — *A. Wagner*, Königsb. Med. Jahrb. 1859, II. S. 115. — *Berend*, Deutsche Klinik. 1864. S. 483. — *Velpeau*, Cancroid of the Auricular Cartilage. Gaz. des Hôp. 1864. No. 27. — *O. Saint-Vel*, Ueber Fibrome. Gaz. des Hôp. 1864. No. 84. — *Virchow*, Geschwülste. III. S. 347. 1867. (Auriculäre Angiome.) — *Jüngken*, Berl. Klin. Wochenschrift. 1869. No. 8. (Gefäßgeschwülste.) *Knapp*, Fibrome des Lobulus. (A. f. A. u. O. V. 1. S. 215.)



Fig. 25.

New Growths. Tumors produced by the collection and retention of the sebaceous secretion of

Atheroma on the Posterior Surface of the Auricle; natural size. (From J. Gruber, "Lehrbuch," S. 407.)

the skin (atheromata), are very frequent, possibly because there are no smooth muscular fibres on the

auricle, through the contraction of which the expulsion of the sebaceous matter is produced.¹ Fibroids (cicatricial keloid) are often developed on the lobule as the result of piercing the ear, and may grow to the size of a hen's egg; they are most common in negresses. Histologically, they show the exact structure of cicatrices in the skin, and frequently recur when imperfectly removed. Angioma,² lipoma, cavernous tumors, epithelial and chimney-sweeper's cancer,³ and cysts are also found. What Wilde⁴ describes and figures as a cyst, is probably a hæmatoma.

Epithelial cancer of the auricle is not unfrequent, and may by extension lead to destruction of the middle and inner ears.

THE EXTERNAL MEATUS.

Malformations. Complete absence of the meatus is found with a simultaneous absence or deformity of the auricle, and also with congenital absence of the membrana tympani (Michael Jaeger). In place of the meatus, a compact wall of bone, several lines thick, is then found. Sometimes at the seat of the entrance to the meatus, only slight, single, double, or multiple depressions exist, or the cartilaginous meatus may

¹ Dr. Sappey, *Gazette de Paris*, 1863, 24.

² Examples of congenital angioma of the auricle are given by Jüngken (*Berliner Klin. Wochenschrift*, 1869, No. 8). They grew in the meatus and in the depression between the mastoid process and the condyloid process of the lower jaw. Jüngken ligated the common carotid artery, as, from a rupture of the tumor, a nearly fatal hemorrhage occurred. Seven years after the operation, there occurred a fresh hemorrhage from the tumor, and death.

³ Have been frequently described on the ear by English surgeons.

⁴ *Practical Observations*, p. 201.

be present, and at the bottom of it, instead of the osseous meatus, there may be a membranous¹ or firm osseous closure (atresia congenita). If the deeper parts of the ear are well formed, this condition is not inconsistent with fair hearing, as has been shown by old observations.²

Sometimes the funnel-shaped end of the narrow cartilaginous portion passes into a very fine canal, which extends farther inwards. In other cases the meatus is narrowed equally throughout its extent, or it may be contracted like an hour-glass near its middle, or it may show a contraction close to the membrana tympani produced by an abnormal projection of the anterior osseous wall. According to Moos³ band-like bridges of connective tissue between the walls of the meatus may occur as congenital malformations. The existence of congenital, *abnormal width* of the meatus, which may be so pronounced that the little finger can be inserted down to the drum-membrane, is of little pathological interest.

Some instances of a *double meatus* are known, which are undoubtedly to be referred to arrest in the closure of the first branchial cleft.⁴ In one case by Velpeau, one meatus led to the drum-membrane, while the second ended in the mastoid process; in one case by Bernard, the two passages communicated

¹ This also occurs near the drum-membrane. Toynbee, *London Med. Gazette*, 1850, p. 645.

² Mussey in New York, 1838, *American Journal*. Schmidt's *Jahrbuch*. 1839, S. 320.

³ *Klinik der Ohrenkrankheiten*, S. 85.

⁴ Voigtel, i., S. 295. Loder, i., S. 148, No. 583. Bernard, *Journal de Physiologie Expérimentale de Magendie*, iv. Blandin. Lincke, *Handbuch*, i., S. 623.

and were covered with a continuation of the external skin.

In childhood, and up to the fourth year (according to Huschke), an ossification gap, closed merely by connective tissue, is found normally in the anterior lower wall, to which Von Troeltsch first directed attention. The knowledge of this fact is of importance, to avoid mistaking it for a carious opening. In adults, remains of this opening are occasionally met with in exceptional cases. During purulent inflammations of the middle ear, ulcerative destruction of the skin over this spot of deficient ossification may occur, and through the opening an extension of the inflammatory process of the meatus may reach the parotid gland and the lower jaw.

Hyperæmia and Hemorrhage. Hyperæmia of the skin of the meatus, with or without swelling, is seen in the beginning of a diffuse otitis externa; in the deeper parts of the osseous meatus during acute inflammations of the tympanum and on the posterior upper wall during inflammations of the mastoid process; venous hyperæmia is also found with disease of the heart and emphysema of the lungs.

Hemorrhages, aside from those of traumatic origin, which are the result of direct or indirect injuries, (fractures of the lower jaw, bruises, etc.), may occur in the skin of the meatus, in the form of ecchymoses and blood-blisters, *i. e.*, hemorrhages between the epidermis and cutis, accompanying inflammations of the middle ear. They are usually situated on the upper wall of the meatus, and may extend directly into the membrana tympani. In the severer forms of otitis media purulenta, before rupture of the drum-mem-

brane has taken place, I have frequently seen an extensive vesicular separation of the epidermis on the upper wall of the meatus produced by a sero-hemorrhagic exudation.

Inflammations and their Results. In addition to the different varieties of inflammation of the skin (erythema, eczema, herpes, pemphigus, erysipelas) the external portion of the meatus is subject to furuncles and phlegmonous inflammation; the inner portion of the osseous meatus, where the cutis is very thin and cannot be separated anatomically from the periosteum, *i. e.*, where the soft tissues consist merely of a periosteum covered with epidermis, is subject to *periostitis*. In the acute exanthemata, also, the skin of the meatus is not always spared; it is well known that the *pustules of small-pox* may show themselves not only on the auricle, but also in the cartilaginous portion of the osseous meatus.

In rare cases diffuse hypertrophy of the epidermis of the papillary bodies (*ichthyosis*), leads to narrowing and distortion of the canal, and to diffuse hypertrophies of the skin and the subcutaneous cellular tissue (pachydermatitis).

The common name, "catarrh of the external meatus," formerly much abused, has anatomically no justification, except, perhaps, in those cases in which the epidermis has been destroyed, as, for instance, in acute, moist eczema; it was used, however, as a general designation of the various forms of inflammation of the skin, which lead to suppuration, and which, in their later stages, cannot, either during life or after death, be sharply defined one from another. For these different processes, the name otitis externa must

be used, but it must be distinctly understood that such an otitis purulenta externa (in which the whole surface of the meatus and drum-membrane is the seat and source of the otorrhœa) is to be regarded as the primary source of profuse suppurations only in very few cases (most commonly in childhood, and with suppurative parotitis in typhus). In the great majority of cases the source of the suppuration is in the *middle ear*, and the pus only flows into the meatus through an opening in the drum-membrane. The otitis externa purulenta without perforation of the drum-membrane which is met with in adults, is usually only an accompanying symptom, or the precursor of acute inflammation of the drum-cavity (sympathetic inflammation, Toynbee).

The otitis externa chronica due to *fungous growths*, *otomycosis*, perhaps the most common form which is found in adults,¹ is characterized by a slight and chiefly serous secretion and a collection of macerated epidermis cells between which the fungus grows. With profuse suppuration the fungus does not meet with a favorable resting-place.

Erythema (erythematous dermatitis) is a hyperæmia and serous infiltration of the papillary bodies. The secretion of the glands is at first diminished, or checked entirely. After the erythema the epidermis scales off, and a profuse hypersecretion of a thin, bright yellow cerumen may follow.

Eczema (acute or chronic) is often confined to the external ear. The vesicles may be visible on the meatus and membrana tympani; in most cases, however, only a red and moist skin, from which the epi-

¹ Vide p. 56.

dermis has been separated, is seen. According as pustules or dry scales are formed with the vesicles the disease is called eczema impetiginosum or squamosum. In obstinate cases chronic eczema of the ear may cause inflammatory hypertrophy of the corium, which can produce stenosis of the meatus, deformity of the auricle, and thickening of the cutis of the drum-membrane.

A not infrequent complication of eczema of the meatus is mucous catarrh of the middle ear, without perforation of the membrana tympani.

Furuncle, or perifollicular inflammation in the skin of the meatus, offers no special peculiarities. In accordance with the anatomy of the parts it occurs only in the external third of the canal, and according to some authors (Verneuil, Roser) develops around the ceruminous glands. The most common seat of the furuncle is the anterior lower wall of the meatus.

Usually several follow, one after the other, and, in some individuals, obstinately recur for many years. Large furuncles may produce a temporary closure of the meatus, so that, if the skin is thick and without redness, they give the impression at first view that union of the walls of the meatus has taken place. As their results a slit-like narrowing of the meatus and free desquamation of the epidermis may remain for some time, by which the passage may be closed. Granulations, growing on the edges of the ruptures through which evacuation has taken place, may simulate a polypus.

The *diffuse inflammation* of the skin is preceded by hyperæmia and swelling, most marked in the vicinity of the drum-membrane and in the membrane itself; it causes destruction and loss of the epidermis and su-

perforation. The fluid elements of the purulent secretion consist in part of a transudation from the greatly enlarged blood-vessels, in part originate in the perspiratory and sebaceous glands. If the blood-vessels are ruptured the pus will be temporarily bloody. The inflammation can extend from the elements of the cutis and involve the subcutaneous cellular tissue, producing there a new formation of round cells (phlegmonous inflammation). If not relieved by early and deep incisions the inflammation may go on to gangrene, extensive destruction, disease of the bone, or even to purulent thrombosis of the sinuses and septicæmia. Also in periostitis of the meatus death may result in exceptional cases from purulent thrombus of the sinuses or meningitis (Toynbee), *without disease of the tympanum and without perforation of the membrana tympani*.¹

As other *results* of inflammation of the meatus should be mentioned; *strictures*, sometimes caused merely by a thickening of the cutis, sometimes by simultaneous hyperostosis. In the cartilaginous portion, especially at the point where the cartilaginous joins the osseous meatus, annular strictures may be formed by a cicatricial circular thickening of the connective tissue. Behind the stricture the osseous meatus may be very much enlarged. Such strictures are very dangerous complications of suppurations of the

¹ The existence of a primary *perichondritis* has not been proven anatomically. From observations during life there is a certain probability that such occurs in some of the tedious inflammations where the swelling is confined to the external half of the meatus and produces deep sinuous abscesses and forms fistulæ under the skin of the meatus; however, neither from my own observation nor from the literature is any case known to me where a necrosed cartilage was thrown off.

middle ear. *Adhesion* of the walls of the meatus, noticed by Emmert¹ with a simultaneous union of the tragus with the antitragus, results from burns, from diphtheria of the middle ear (my own observation) in connection with cicatricial adhesions of the palate, and frequently in cases in which there is caries of the middle ear. The meatus is closed either by a membranous diaphragm which has one or more fine openings in its centre, or else the osseous portion of the meatus is completely filled by a new fibrous tissue (my own observation).

A *new growth of slight bands*² uniting the walls of the meatus with each other is sometimes found, but much more frequent are *granulations* (polypoid excrescences) from the cutis, which sometimes completely fill the inner portion of the meatus, and may give the surface of the membrana tympani the appearance of a granulating wound. Thickening of the cutis, opacity or perforation of the drum-membrane, is also found.

Fistulæ in the neighborhood of the meatus, and fistulous perforation of its walls, are usually the result of caries and necrosis (often of abscesses of the middle ear which break through the posterior upper wall of the meatus, and which are frequently mistaken for primary abscesses and furuncles of that passage); such fistulæ may, however, result from suppuration of the parotid³ and the neighboring lymph glands without an affection of the bone, and may also result from cancer. Abscesses of the parotid usually rupture at the junc-

¹ *Chirurgie*, III. Auflage, S. 173.

² *A. f. O.*, ix., 237.

³ Virchow, *Charité-Annalen*, 1858, viii., 3. C. E. E. Hofmann, *A. f. O.*, iv., S. 283.

tion of the cartilaginous with the osseous meatus or else through the incisuræ Santorini. Vice versa in childhood a suppuration of the meatus may extend to the parotid gland and articulation of the jaw through the ossification gaps already described (p. 40). Fistulæ under the skin of the cartilaginous meatus occur from affections of the bone, from phlegmonous abscesses in front of the tragus, and possibly, although this is doubtful, from perichondritis.¹

Ulceration is rare. Simple erosion-ulcers at the entrance of the meatus may occur from inflammations, attended by profuse and putrid suppuration; ulcers are also sometimes found with caries and necrosis, with syphilis, and with epithelial cancer. Von Troeltsch² found an ulcer with sharply projecting edges extending down to the bone on the posterior wall, close to the membrana tympani, in a case of miliary tubercular meningitis with simultaneous suppuration of the middle ear. The ulcers found with constitutional syphilis are annular and covered with a dirty grayish white exudation; from their edges being greatly swollen they cause contraction of the meatus, and when they exist the lymph glands in the vicinity of the ear are much swollen.

The skin of the meatus, if it has lost its epidermis from moist eczema, or from any other cause, may, like the skin of the auricle when affected by intertrigo, assume the character of a diphtheritic ulcer, and this has been called by Wreden³ and by Moos⁴ an independent, primary diphtheritis of the skin of the meatus. This diphtheritic ulceration of the meatus may

¹ *Vide* p. 45, remarks.

² *A. f. O.*, iv., 130.

³ *M. f. O.*, 1868, No. 10, S. 154.

⁴ Moos, *A. f. O.*, vi., S. 162.

lead to cicatricial adhesion of the walls of the passage.¹

Collapse of the meatus means a slit-like contraction of the passage in its cartilaginous portion, seen particularly in old age, and often produced (Von Troeltsch) by a relaxation of the fibrous attachments of the membranous posterior and upper portion of the meatus to the squama. From this relaxation the posterior wall of the cartilaginous meatus falls against the anterior wall.

Hyperostosis with narrowing of the meatus is most commonly found with caries of the middle and inner ear, and is a cause of retention of pus; it is found, moreover, with non-purulent chronic inflammations of the middle ear, associated with a growth of connective tissue around the ossiculæ, and also frequently exists with osteo-sclerosis in the mastoid process and roof of the tympanum. According to J. Gruber,² not only a thickening of the osseous portion of the meatus takes place, but the ossification extends outwards along the cartilaginous meatus so that the new growth of bone may reach nearly to the orificium externum.

Caries and Necrosis. The spot of preference for caries of the meatus is the posterior upper wall near the membrana tympani, corresponding either to the floor of the antrum mastoideum, or to the point where the antrum enters the tympanum. Preceding the rupture of the cutis the skin of the meatus on its upper and posterior wall appears thickened and infiltrated with pus; later granulations



Fig. 26.

The Head of the Hammer exposed from caries of the upper wall of the meatus.

¹ Vide p. 45.

² *Lehrbuch der Ohrenheilkunde*, S. 387.

are seen projecting from the carious opening, or the opening itself can be seen surrounded by extruding edges of skin. If the carious destruction attacks the upper wall of the passage near the drum-membrane, the head of the hammer, either in articulation with the body of the incus or separated, will be fully exposed and can be readily seen on inspection. If both of these ossicles have been lost the corresponding portion of the tympanum is exposed.

Partial necrosis of the osseous meatus with the loss of large portions of its walls results quite frequently from long continued suppurations, especially in childhood. The os tympanicum alone may also be attacked by necrosis.

Anomalies of Secretion are noticed in the sebaceous and perspiratory glands of the cartilaginous meatus. The meatus of the new-born child contains vernix caseosa, which completely covers the membrana tympani. A hypersecretion of the glands (seborrhœa) is very common,¹ and forms, from long retention and thickening of the secretion due to the loss of its fluid elements, obstructing masses which may by mechanical irritation cause secondary inflammatory changes in the skin. Whether changes in the glands themselves, such as hyperplasia or degeneration of the glandular epithelium, is the cause of the frequent recurrence of such masses, remains to be investigated.

These masses only produce a functional disturbance when they hermetically close the meatus or lie on the drum-membrane. They show a variable ana-

¹ From the presence of foreign bodies the inflammatory irritation of the skin very rapidly produces hypersecretion of the glands, by which the foreign body may be in a few hours completely embedded and covered.

tomical composition. Some consist almost entirely of the secretion of the sebaceous and sweat-glands, others are chiefly composed of masses of epidermis arranged in lamellæ (cul-de-sacs of epidermis resembling the finger of a glove and filled with glandular secretion). Hairs, round or oval bodies resembling corpora amylacea but not giving the well-known reaction to iodine, occasionally an acarus,¹ and mould-fungus, are also found in these masses. Their surfaces are sometimes glistening from cholesterine. They are found at all ages, but are especially common in old age.

If the mass completely fills the meatus down to the membrana tympani, which in most cases is not the fact, a perfect impression of the drum-membrane with all its characteristics is often found on the inner end of the mass. In addition to secondary inflammatory irritation of the skin these masses may produce atrophy or ulceration of the membrana tympani from pressure, but still more commonly, by forcing the drum-membrane inwards, they favor the adhesion of that membrane to the inner wall of the tympanum; they may also cause a circumscribed atrophy of the osseous meatus, and thus enormously enlarge that passage. Von Troeltsch² has described a case where one of these masses was the cause of a fatal facial erysipelas. On the other hand such masses are not uncommonly complicated by other and wholly independent

¹ First found by Berger in cerumen (*Comptes Rendus*, xx., S. 1506, 1845); previously seen by Henle in the sebaceous glands of the meatus (Müller's *Archiv*, 1842, S. 237).

² *A. f. O.*, vi., S. 48.

diseases of the middle ear, for instance, synostosis of the stapes, of which Morgagni¹ gives an example.

New Growths. Concretions of carbonate and phosphate of lime, which have formed in the ear, have been found in the meatus; they are analogous to nasal concretions. In horses similar concretions of an ivory consistency frequently exist.

Encysted tumor has been seen once by Pappenheim.² It was attached by a small pedicle to the skin and closed the meatus; it consisted of a cavity formed by the corium and epidermis, and was filled with a white, slightly glistening contents consisting of cholesterine, epithelial cells, fat globules, and crystals of lime.

The tumors described by Toynbee under the name "sebaceous tumors" are not to be considered as encysted tumors but cholesteatomata.

Milium may occur in the meatus, as on the eyelid, in the form of a white, round protuberance, of the size of a millet-seed. It is formed from an obstructed sebaceous gland.

Pedunculated warts covered with a normal cutis containing hairs and sebaceous and sweat glands are very rare. They were found by Von Troeltsch³ in two cases originating from the upper wall; in one case the growth was quite near the drum-membrane.

Polypi, pedunculated tumors, may have their origin from any point of the meatus, usually, however, they grow from the osseous meatus near the membrana tympani, and should not be confounded with the

¹ *De Sedibus et Causis Morborum*, lib. i., ep. xiv., art. 11.

² *Spec. Gewebelehre des Gehörorgans*, 1840.

³ *Lehrbuch*, 6 Aufl., S. 504.

granulation-growths of the meatus already described on p. 45. In one case described by Billroth, the tumor originated from the cellular tissue between the cartilage and the skin. In regard to their histological structure it should be said, that they are always covered with a pavement epithelium, and that they contain neither glands nor cysts like the polypi of the middle ear, although like these latter they may have a papillary structure. Polypi of the meatus are much more rare than polypi of the middle ear, but do occur with an imperforate drum-membrane. Sometimes, however, they exist simultaneously with purulent inflammation of the middle ear.

For a more minute account of aural polypi, compare the chapter on the tympanum.

Exostoses,¹ congenital or acquired, pedunculated or with a broad base, spongy or eburnated, are found. The eburnated may be developed from the spongy variety, and perhaps *vice versa*. Both are only different stages of development of the same process. Their seat is generally at the beginning of the osseous meatus or close to the membrana tympani, usually on the upper wall. The calibre of the meatus may be almost or even wholly destroyed by them, but as long as a slit even remains open no disturbance of the hearing is no-



Fig. 27.

Exostoses of the Meatus. From Welcker, "A. f. O.," i., Table 2, Fig. 7.

¹ C. O. Weber, *Die Exostosen und Enchondromen*, Bonn, 1856. Welcker, *A. f. O.*, i., S. 163, 1864.

ticed. It very easily occurs, however, under such conditions, that the glandular secretion and the scales of epidermis are collected and retained behind or between the exostoses, and thus hermetically close the meatus. From the pressure of the exostoses against the opposite wall, painful inflammation of the meatus



Fig. 28.

Exostoses on the Posterior Wall of Meatus
near the drum-membrane.



Fig. 29.

Exostoses of the Meatus.

with the formation of granulations may take place, and from the retention of the pus may lead very rapidly to perforation of the drum-membrane and supuration of the tympanum.

Exostoses are much more frequent in men; are particularly common, according to Welcher, in the skulls of transmarine races. Toynbee considered rheumatism and arthritis as their causes: I have often seen them hereditary and unassociated with these diseases. Syphilis is certainly to be excluded as a cause. With chronic suppurations of the middle ear exostoses and a tendency to hyperostosis often form a dangerous complication, as they especially favor the retention of the pus.

Epithelioma of the meatus, in the form of a rough wart, is described by Kessel.¹

Cholesteatomata occurring primarily in the meatus

¹ *A. f. O.*, iv., S. 184.

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are described in large numbers by Toynbee,¹ as sebaceous tumors, although it is doubtful if he is not referring to the so-called cholesteatomata of the tympanum or antrum mastoideum,² which, after destruction of the membrana tympani or of the posterior wall of the meatus, are pressed forward into the meatus. Toynbee certainly ascribes to these "sebaceous tumors," a firm enveloping membrane of connective tissue, which has its origin on the floor of the meatus, near the drum-membrane, (?) and he considers that the meatus may be considerably enlarged by the tumor, and finally, that the bone may be perforated by a gradual atrophy produced by the pressure of the mass. According to him the membrana tympani may often remain intact and pressed in against the labyrinthine wall; in other cases, however, it may be perforated, and through the opening a portion of the tumor may project into the tympanum.

Enchondroma may arise from the cartilage of the meatus and simulate a parotid tumor.³

Cylindroma is a name given by H. Meckel von Hemsbach to a form of tumor, of which he has described one example.⁴ According to the terminology of the present day it would perhaps be called a myxoma cartilagineum.

In a man about forty years of age, a subcutaneous tumor gradually developed in the course of a half year in front of and below the external meatus. It was extirpated by Von Bärensprung. The tumor originated from the cartilaginous wall of the meatus. Within the passage were merely small flat yellowish nodules; on the outer

¹ *Med.-Chirurg. Transactions*, vol. xliv., p. 51.

² *Vide* p. 22.

³ Launay, *Gaz. des Hôp.*, 1861, 46.

⁴ *Charité Annalen*, Band vii., S. 105, Fall 2.

surface of the meatus, however, was a yellowish, transparent enchondromatous mass of the size of a walnut, consisting of numerous sharply defined lobules. Microscopically it showed in all parts the uniform structure of a pure cylindroma.

Injuries of the meatus from sharp substances are very common, but are destitute of important results if the membrana tympani and the parts of the ear behind it are untouched. From the intentional infusion of melted metals and mineral acids into the ear, and the thrusting of sharp substances as far as the inner ear, severe inflammations with a fatal result have been caused.

From the action of force on the under jaw (kick of a horse) fractures of the anterior wall of the meatus with fracture of the glenoid cavity but without injury of the deeper parts, and especially without extension of the fracture to the base of the skull, and without rupture of the drum-membrane, not infrequently occur.

Fractures of the base of the skull occasionally extend into the osseous meatus, and may even break off and completely separate pieces of the bone.

Limited fractures, which do not extend to the base of the skull, sometimes occur in the extremely thin upper wall of the meatus from contusion of the head. This may produce injury of the brain and evacuation of brain substance from the ear, without death necessarily resulting.

Parasites.

Animal: *Huber*, Virchow's Archiv. Bd. 22. *Gerlach*, Allgemeine Therapie der Hausthiere. 2 Aufl. Berlin, 1868. *Zürn*, Die thierischen Parasiten auf und in dem Körper unserer Haussäugethiere. 1872. *Zürn*, Die Ohrkrankheiten der Kaninchen. Deutsche Zeitschrift für Thiermedizin und vergl. Pathologie. 1 Bd. 1870. *Von Troeltsch*, A. f. O.

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IX. S. 198. 1875. *Trautmann*, Protocoll der Section für Ohrenh. auf der Versammlung Deutscher Naturforscher und Aerzte zu Hamburg. 1876. A. f. O. XI. S. 272.

Vegetable: *Mayer*, Müller's Arch. f. Anat. u. Phys. 1844. S. 404. *Pacini*, Gaz. Med. Ital. 1851. I. Ser. II. *Grove*, Quarterly Journal. 1857. Vol. V. p. 161. *Cramer*, Vierteljahrsschrift der naturforsch. Gesellsch. zu Zürich. 1859, 1860. *Schwartz*, A. f. O. II. S. 5. 1865. *Wreden*, A. f. O. III. 1, 1867. *Wreden*, Myringomycosis Aspergillina. Petersburg. 1868. *Steudener*, A. f. O. V. S. 163. 1870; and a large number of later observations.

The existence of animal parasites (acari, gregariulæ), especially *dermanyssus avium*, *symbiotes*, *dermatophagus*, *dermatodectes*, has been known for a long time to the veterinary pathologists as a common occurrence in the meatus of some animals (cow, horse, dog, cat, rabbit, goat), where they may cause inflammations or deep necrosis, even into the labyrinth; their transmission to the human ear, however, with the exception of *acarus folliculorum*,¹ has not yet been observed, although from the close relations of many persons with cats and rabbits it is very possible.² On the other hand *vegetable parasites* (*aspergillus*, *ascophora elegans*, *trichothesium roseum*, *mucor mucedo*) are, according to recent observations, much more common than was formerly supposed, if one may judge from the few references to them in the older writings.

The attention of aural surgeons was first directed to this point by a communication of the author in 1865; and soon communications from all sides and from every country were published, so that the fact is now fully established that vegetable parasites, chiefly mould-fungi (*aspergillus niger*), are developed and

¹ Compare p. 49.

² *Dermatodectes* in the ear of the rabbit was first observed by Gerlach; *symbiotes cati* in the ear of the cat by Huber. (*Virchow's Archiv*, Bd. xxii.)

find nourishment in the human meatus auditorius and produce very obstinate and recurring inflammations of that passage and of the drum-membrane (otomycosis of Virchow). On the healthy skin of the meatus no fungus can live and fructify; it is necessary for the development of the growth that there should exist an abnormal condition, possibly loosening of the epidermis, or a superficial inflammation of the skin. In my opinion we have to deal not with a parasitic inflammation, but the parasitic growth upon and among the epidermal cells is an accidental but important accident of the inflammation. A new irritation is added by the fungus, hyperæmia and exudation are increased, the increase in the vegetable growth interferes with the removal of the secretion, and of the loosened layers of epidermis, and may finally close the median portion of the meatus. The surface of the membrana tympani may be infiltrated with the fungus,¹ and if there is a perforation of that membrane, the tympanic mucous membrane may be affected.

The diagnosis of otomycosis can frequently be made with certainty with the naked eye. The fibres of the fungus with their heads of fructification in insular groups are recognized clearly in profile against the wall of the meatus, or a peculiar white, felt-like deposit is seen on the membrana tympani. In many cases, however, the diagnosis is doubtful without the use of the microscope. Most frequently the otomycosis is mistaken for a chronic eczema squamosum.

It should be added here that insects (*musca*, *pulex*,

¹ From an observation of Politzer's it is established that the fungus may even penetrate the tissue of the drum-membrane.

myriapodes) and their larvæ may get into the meatus, and where destructive processes have already taken place, may reach the middle and inner ears. It should also be mentioned that pus in the meatus often contains numerous bacteria and vibrios. Leyden¹ found in the pus of a carious ear, "fine spirals of from three to six turns which sometimes by wave-like motion beat the surrounding fluid and sometimes contracted themselves together." They belong to the lowest vegetable organisms (schizomycetes).

THE DRUM-MEMBRANE.

Cassebohm, Tractatus IV. Anatomici de Aure Humana. Halæ, 1734. First describes the deposits of lime in the drum-membrane. *Platner*, Diss. de Morbis Membranæ Tympani. Leipzig, 1780. *Gniditsch*, De Morbis Membranæ Tymp. Dissertatio. Leipzig, 1780. *Von Troeltsch*, Virch. Arch. XVII. u. f. und Lehrbuch. *Politzer*, Beleuchtungsbilder des Trommelfells. Wien, 1865. *Politzer*, Zur Patholog. Anatomie der Trommelfelltrübungen. Oesterr. Zeitschr. für Prakt. Heilk. 1862. VIII. 43, 46, 51. *Gruber*, Lehrbuch, 1870. *Wendl*, in seinen Anatomischen Beiträgen in Wagner's Archiv für Heilkunde. *Hinton*, Atlas of the Membrana Tympani with descriptive text. London, 1874.

Pathological changes of the drum-membrane are extremely common, but are rarely the result of a primary and isolated disease of that membrane. In most cases they are to be regarded as the secondary results of diseases of the middle ear, and of the external meatus. Dissection alone cannot give us sufficient information in regard to the changes observed during life, because we are dealing with an organ which soon after death changes its color, polish, transparency, and curvature. From the ease, however, with which the membrana tympani can be examined during life, this defect in anatomical investigation can be readily corrected.

For examining the histological changes, cross-sections of the membrane are best adapted. The membrane should be laid for some days in a weak solution of chromic acid, then in absolute alcohol, and should then be embedded in gum or glycerine-glue.

¹ Volkman, *Klinische Vorträge*, i., No. 26.

Malformations. Congenital absence of the drum-membrane, as an isolated malformation, without simultaneous absence of the osseous meatus, is doubtful. Itard, Claude Bernard, Bonnafont,¹ and Erhard,² claim to have seen cases where there was no dividing line between the meatus and the tympanum, and the lining membrane of both was of the same character and color. Mistaking an acquired loss of the membrane for congenital absence, is very easy, because in such cases the epidermal covering of the meatus often extends over the mucous membrane of the tympanum. It is certain that absence is often considered to be congenital where it has clearly been caused by disease, as, for instance, in the case of Elsässer.³ Congenital absence of the membrane must certainly be very rare. I myself have never seen an instance of it.

The existence of congenital double membrana tympani is also very doubtful. The examples of it given by Duverney, Koehler, and Oberteuffer are in reality membranous new growths in the meatus.

As the upper portion of membrana tympani in the very young embryo is, according to Huschke, not closed, it may happen, in very rare cases, that in adults an arrest of development, in the shape of an opening in the upper portion of the membrane, may be seen. This corresponds in analogy with the coloboma iridis. It is produced by the failure of the true membrana tympani to unite with the membrana flaccida. Such openings are sometimes found on both

¹ *Lehrbuch*, II. Auflage, S. 275.

² *Rationelle Otiatrik*, S. 14.

³ Hufeland's *Journal d. Pract. Heilkunde*, 1828, II. 7, S. 123, note.

sides and associated with other forms of arrest in development (cleft uvula, Von Troeltsch). The so-called foramen Rivini, described in 1717 by Professor Rivinus of Leipzig, and previously by Professor Marchetti of Padua, in 1652, was for a long time the source of active controversy.¹ It was described as a normal attribute of the drum-membrane, even very recently by Professor Bochdalek, of Prague (1866²). It was sometimes referred to the middle, sometimes to the upper portion of the membrane.

A normal foramen Rivini does not exist. In most cases where such an opening exists, and it is by no means uncommon in the membrana flaccida Schrapnelli which is not involved in the functions of the ear, it is the result of previous inflammation; only in very rare cases is it in man a congenital arrest of development, although in the insect-eating animals it is more common.³

Anomalies in form, size, and inclination of the membrane are frequent, but of no importance. Among the numerous varieties in form, the most note-

¹ The existence of the foramen Rivini is denied by Hildebrandt, Mayer, Meckel, Rudolphi, Cornelius, Cloquet, Linke, Engel; it is doubted by Ruysch, Pauli, Walther, Cassebohm, Haller; it is maintained by Colle, Marchetti, Glaser, Rivinus, Munniks, Cheselden, Teichmayer, Scarpa, Berres. The opening is regarded as merely an exceptional arrest of development by Huschke, Hyrtl, Dursy.

² *Prager Vierteljahrsschr.*, 1866, Bd. I., S. 33-46. Bochdalek, Jun., affirms the existence of Rivinian openings or canals (*Oesterr. Zeitschr. für Prakt. Heilkunde*, 1866, Nos. 32, 33). He considers only the anterior canal to be perfectly constant, and this opens into the anterior pouch of the drum-membrane. The external opening in the drum-membrane is surrounded by a projecting distinctly fibrous ring when examined microscopically.

³ Bonnafont (*Traité*, etc., p. 273) has twice seen congenital openings in the drum-membrane.

worthy is the triangular form described by Koehler.¹ The size of the membrane depends on the variable, individual width of the meatus. The normal diameter of the elliptical membrane is 9–10 mm. in its greatest length, and 8.7–9.4 mm. in its greatest breadth.

Among the anomalies of inclination should be mentioned the very perpendicular position of the drum-membrane as seen often in very musical people; and the nearly horizontal position of the membrane (normal in the new-born child) as seen in adults with congenital deafmutism and with cretinismus. Von Troeltsch² thinks, that from the degree of inclination of the drum-membrane, it is perhaps possible to judge of the higher or lower position of the sphenoid bone and of the degree of perfection of the skull in general; in other words, that there seems to be a legitimate connection between the anomalies of inclination in the drum-membrane, and those of development in the base of the skull. In the normal meatus of adults, the average normal angle of the drum-membrane, *i. e.*, the angle which the membrane forms with the upper (or posterior) wall of the meatus, is given by Von Troeltsch as 140°.

Congenital anomalies of inclination should not be confounded with acquired anomalies of curvature, as frequently happens in an examination by inexperienced persons.

The manubrium may be inserted into the membrana propria in a false direction, for instance, it may

¹ *Beschreibung der Loder'schen Sammlung*, Leipzig, 1795, S. 188, No. 582.

² *Lehrbuch*, V. Auflage, S. 39.

be directed forwards and downwards, or it may be curved like a sabre throughout its whole length, or merely at its lower end.

Hyperæmia. On the normal drum-membrane and along the manubrium no blood-vessels are visible; but temporary and slight irritation of the skin of the meatus, or a touch on the membrana tympani, are sufficient to produce momentary injection of the vessels of the manubrium. Where these vessels appear permanently congested and enlarged, in the form of a bright or light red bundle of vessels along the posterior edge of the manubrium, or wholly covering that bone, it is either a sign of inflammatory irritation in the drum-membrane or tympanum, or else a symptom of habitual congestion of the head.

This hyperæmia in the vicinity of the hammer frequently appears as a direct extension of a hyperæmia of the walls of the meatus. In its higher degrees it is not confined to the immediate neighborhood of the manubrium, but extends over a triangular portion of the drum-membrane near that bone, the base of the triangle being directed upwards.

Passive hyperæmia in the venous ring on the periphery of the membrane is a common appearance with hyperæmia of the tympanic mucous membrane. When it is very marked, numerous radiating vessels are seen in the cutis of the drum membrane anastomosing with the vessels of the manubrium, becoming wider as they extend outwards, and finally joining the venous ring on the periphery. In the highest stage of hyperæmia of the cutis of the drum-membrane the single capillaries are no longer seen, but the membrane has a diffuse red color, the intensity of

which varies, according to the degree of hyperæmia, from pink to bluish red, copper red, and scarlet. Such hyperæmias of the skin are often seen without hyperæmia of the mucous membrane; when they are present the hammer is not visible. With normal or increased transparency of the drum-membrane, a violet appearance may be given to the membrane by reflection from the hyperæmia of the labyrinthine wall of the tympanum, the drum-membrane itself not participating in the hyperæmia. With muco-purulent catarrh of the tympanum without perforation, the hyperæmia of the drum-membrane is sometimes confined to its mucous layer; this is more especially the case on the periphery or on certain isolated spots of the membrane. In the majority of cases, however, both the skin and the mucous layer of the membrane are simultaneously hyperæmic. The lamina propria is either entirely destitute of vessels, or is perforated at its edge by single small capillaries.

Hemorrhage. Spontaneous and traumatic hemorrhage in the substance of the membrana tympani is seen as minute ecchymoses, superficial extravasations, hæmatomata and hemorrhagic infiltrations, and may occur either in the layer of skin or of mucous membrane, sometimes in both simultaneously. It is found with simultaneous hyperæmia of the tympanic mucous membrane during measles, small-pox, typhus, scurvy, from compression of the lungs by pleuritic exudation, and from other causes which produce congestion of the vena cava superior, from endocarditis and also from primary inflammations of the drum-membrane. The hemorrhages may occur just in front of or behind the manubrium, in the posterior upper part of

the membrane, and also at other spots. Hemorrhagic infiltration is sometimes found on the edges of perforations, and appears as an ill-defined bluish-black thickening of the edges. Hæmatoma in the mucous layer appears as a bluish-red, sharply defined, round or oval prominence above the plane of the mucous membrane. It was first described by Wendt,¹ who found it in the dissection of small-pox cases. The remains of extravasations I have often seen as grayish-black pigmentations of the mucous layer, like the pigmentation in the intestinal mucous membrane after cholera infantum. The ecchymoses which occur under the epidermis change their position and wander in the course of a few weeks towards the periphery of the membrana tympani, generally towards the posterior upper wall, and from there pass on to the skin of the meatus. This very peculiar locomotion was first described by Von Troeltsch,² and has since been noticed in various ways. It has been thought that its cause was an eccentric growth of the epidermal covering, while Zaufal endeavors to explain it by capillary action, and Kessel thinks that the extravasation is within the lymph-vessels, and its motion dependent on the movement in these vessels.

Inflammation of the Drum-Membrane (myringitis) and its results. An independent primary inflammation of the drum-membrane is relatively rare, and is usually found only on one side. In most cases, inflammation of the tympanum or of the meatus is also present, and the inflammation of the drum-membrane makes its appearance as a secondary affection.

¹ *Arch. f. Heilkunde von Wagner*, xiii., S. 128.

² *Lehrbuch*, V. Aufl., S. 131, note.

In the acute form of myringitis, the membrane appears flattened and the manubrium indistinct from hyperæmia and serous infiltration of the layer of cutis. The position of the manubrium is only recognized by a red line of blood-vessels. The epidermis is macerated, becomes loose and is destroyed; owing to this the corium is exposed, and appears red, loosened, and swollen. The swelling is the result of serous and cellular infiltration. In the mucosa immense numbers of cells are found in the connective tissue stroma, and the blood-vessels are enlarged. The substantia propria shows a peculiar swelling and softening of the fibres from which the drum-membrane assumes a soft relaxed condition, and is very easily torn. The meatus near the membrana tympani, if not originally affected, participates secondarily in the inflammation, the sharp boundary between the meatus and drum-membrane disappears, and the membrane itself looks smaller than natural on account of the swelling of the meatus.

Sometimes ecchymoses and interlamellar abscesses occur in the membrane. In very rare cases perforating ulcers are found. (Fig. 30.)



Fig. 30.

An Ulcer perforating from without inwards in the central portion of the drum-membrane.

Acute diseases of the skin of the meatus sometimes extend on to the skin of the drum-membrane, and the vesicles of eczema and pemphigus have been seen on it. I have never seen the phlyctenular form of myringitis occurring with scrofula as it is described by Triquet.¹ Pos-

¹ *Presse Méd.*, 1863, 18.

sibly this is owing to its being confounded with vesicular prominences of the skin or with the vesicles of eczema.

The *chronic inflammation* of the membrana tympani, which comes under observation frequently, is also seldom an isolated disease, but is usually only an accompaniment of simultaneous inflammation of the tympanum. The membrane is covered with pus, is thickened, flattened, of a yellowish gray color, with radiating varicose blood-vessels, and occasionally with polypoid excrescences. No part of the hammer, except perhaps the processus brevis, can be recognized. In the substantia propria there are deposits of fat and lime, in the mucous membrane infiltration with round cells; cysts also are sometimes formed.

The walls of the meatus are, in their external half, of nearly normal appearance, in their inner half, near the drum-membrane, usually covered with black crusts, but nowhere with fresh pus.

The myringitis parasitica (myringomycosis aspergillina, Wreden's), described by Wreden as an independent disease, is only one of the appearances of otomycosis.¹

Nassiloff² has given the name myringitis villosa to a form of chronic inflammation, in which *papillary outgrowths or villi* from 0.06 — 0.25 mm. in length are developed on the external surface of the membrane with an increase of vascularity; at the same time the fibres of the drum-membrane may be supplanted by a new growth of a vascular connective tissue in the cutis and membrana propria.

¹ *Vide* p. 56.

² *Med. Centralblatt*, 1867, No. 11.

According to Nassiloff, these villi are covered with several layers of pavement epithelium; according to Kessel, by a single layer of cylinder epithelium, with peculiar variations in form. Both are apparently only different stages of development of the same new growths,¹ and are analogous to the polypoid inflammations of the mucous membrane.

As results of inflammation of the membrana tympani should be mentioned: —

1. *Anomalies of color and transparency.* Aside from individual variations in color and transparency which the healthy drum-membrane may offer, *opacities and thickenings* are often found as the result of inflammatory processes. The smoky-gray or pearl-gray color of the normal membrane may become deep gray, whitish gray, yellow, or yellowish red. All these variations of color are seen much more pronounced on examining living subjects than they are on the dead body, where they are indistinct if the preparation is not perfectly fresh, and have often wholly disappeared if the preparation has been in spirit.

The transmission of color from the contents of the tympanum, whether due to abnormal conditions of its mucous membrane or to the collection of secretion in the cavity, have an important influence on the changes of color. The infantile drum-membrane, on account of the greater thickness of its cutis and mucous layers, always appears a thicker whitish gray than does the membrane of adults, and it is possible that this variation from the normal color sometimes continues till adult life as an anomaly of development.

¹ S. Kessel, *Zur Myringitis Villosa*. A. f. O., v., S. 250.

In old age a whitish discoloration of the membrane is by no means to be referred to the physiological changes due to age.¹

Opacities do not always correspond with *thickenings* of the membrane, but are also found with atrophic processes. According to their extent, position, and form, we distinguish partial and total opacities, peripheral and intermediar, crescentic, speckled, striated, etc.

The histological substratum of opacities is variable; most frequently it is a new growth of connective tissue together with changes in the superficial layer of epithelium, such as deposition of fat and lime, albuminous infiltration, or else a new growth of connective tissue in the lamina propria. It is rare that a single layer of the drum-membrane is the seat of an opacity; usually all three layers, on account of their intimate relations, are simultaneously affected by the pathological processes. Thickenings generally occur from an increase in the thickness of the superficial layers of the membrane, rarely of the fibrous middle layer. (The normal thickness of the membrane is 0.1 mm.)

Partial opacities most commonly begin in the substantia propria, but, with very few exceptions, extend from that into both the superficial layers. They appear as irregular yellowish-white or white specks and lines, at first with indistinct, later with sharply defined edges. They are caused by fatty degeneration of the membrana propria itself, or by a new

¹ Gruber describes, as a frequent appearance in old age, a peripheral yellowish or milky opacity, which is usually due to fatty degeneration of the substantia propria. — *Lehrbuch*, p. 398.

growth of connective tissue between the fibres of that membrane, thus crowding these fibres together.

A *crescentic intermediar opacity* behind the manubrium, the convexity directed towards the periphery, is a frequently recurring variety. It often exists with simultaneous hypertrophy and adhesive inflammation of the mucous membrane (synechiæ within the tympanum). Some intermediar opacities, it should be stated, are only optical appearances on the membrana tympani, and disappear whenever the drum-membrane can be examined perpendicularly to its surface. In other cases partial opacities in the form of irregular specks and striæ (tendinous opacities) are seen, which inclose atrophic spots in the membrane. These are found more especially with rigidity and ankylosis of the ossicles.

The so-called *peripheral opacities* are peripheral, whitish-gray opacities, varying very much in the intensity of their color; they are produced by a deposition of fat-globules between the circular fibres of the lamina propria, which fibres are, in the normal condition, closely crowded together on the periphery of the membrane; or else they are caused by a thickening of the mucous layer of the membrane, which in this region possesses in the normal condition, villi or papillæ, as was first described by Gerlach.

When these peripheral opacities are very well marked there always exists a simultaneous pathological thickening of the tympanic mucous membrane, and it will be noticed that the central portion of the membrana tympani appears darker and more transparent than usual, and apparently or in reality is curved deeper inwards than is natural.

Calcifications in the membrana tympani are very common. They may occur as isolated affections without pathological changes in the deeper parts of the ear and with a normal hearing; more commonly they are the remains of previous suppurative processes in the ear, but they are also found in deaf persons with non-suppurative inflammations of the middle ear.



Fig. 31.



Fig. 32.



Fig. 33.



Fig. 34.

FIG. 31. Calcifications in the Drum-membrane.

FIGS. 32 and 33. Calcifications and Cicatrices.

FIG. 34. Calcification of the whole Drum-membrane seen from within, with a cicatricial formation in the posterior upper quadrant. The calcified membrane projects sharply into the tympanum and is as hard as bone.

The most common form of calcification is a crescent before or behind the manubrium; the horse-shoe variety is less common. In the highest degrees of calcification the deposit extends over the whole membrane, but this occurs only after suppurative processes. The drum-membrane is then transformed into a perfectly rigid stony plate, sometimes of considerable thickness (2-3 mm.).

Besides the crescentic form the deposits of lime occur as irregular and radiating striations from the end of the manubrium towards the periphery of the drum-membrane.

A central calcification surrounding the manubrium is very rare. Beginners in otoscopy can easily mistake the yellow appearance of the end of the manubrium, which is visible under normal conditions, for a calcification.

The *seat* of calcification is either the lamina propria alone, in which case the superficial layers of the drum-membrane are easily separated under water by means of needles from the calcification, or else all three layers of the drum-membrane are calcified; in this latter case the deposit often projects above the surface of the mucous membrane, rarely above that of the skin.

The thickened epidermis of the membrana tympani appears to be very rarely indeed the sole seat of lime deposits (Lucae).

The deposition of amorphous lime-particles takes place in the membrana propria, partially between and in its fibres, partially in the drum-membrane corpuscles; with the lime there is usually much fat, seldom any pigment. According to Wendt, the deposition occurs in the endothelial sheaths which surround, like a tube, the processes of the fibrous framework of the membrane. The histological changes near the calcified spots extend further than would be supposed from the clearly defined edges of the deposit. Exceptionally crystallized lime is found, as was first described by Von Troeltsch.¹ Bauer² found crystals

¹ *Virchow's Archiv*, xvii., S. 16.

² *Diss. Inaug.*, 1863, Marburg.

of phosphate of lime in the membrana tympani of hemicephali, with deposits of the same salt in the tympanum and labyrinth, and the stapes was completely imbedded in a solid crystalline mass of lime. Lucae¹ found crystals of carbonate of lime (aragonite) in the peripheral portion of the thickened epidermis of the membrana tympani in a case of chronic catarrh of the middle ear.

The existence of a *new growth of bone* near calcified portions of the membrana tympani in man was first proved by the histological investigations of Politzer, and was later confirmed by Wendt from his own dissections. Microscopically large and numerous bone corpuscles with short processes are seen.

Partial opacities may, finally, be produced according to Gruber,² by a duplicature of the drum-membrane and the union of the mucous surfaces by connective tissue. They result from long continued closure of the Eustachian tube, are usually situated in the posterior segment of the membrane, pass backwards in a curve from the processus brevis and resemble a strongly developed, so called posterior fold. The affected segment of the membrana tympani appears diminished in size and is opaque. Partial opacities produced in the same way may, according to Gruber, also occur on the anterior segment and assume a circular shape.

Similar opacities can be produced by a growth on the mucous membrane or by a union of the pouches of the membrana tympani.

Total opacities of the drum-membrane are most

¹ *Virchow's Archiv*, xxxvi., June.

² *Lehrbuch*, S. 402.

frequently produced by a thickening of the mucous membrane, one of the results of the general thickening of the whole tympanic mucous membrane which occurs from chronic catarrhs. The thickening of the mucous layer of the drum-membrane may be so extreme as to be five times the normal thickness (0.1 mm.) of all the layers together. The thickening is caused by enlargement of the blood-vessels and the presence of large numbers of cells in the connective tissue stroma. The epithelium remains intact. Examined externally during life the membrana tympani appears in such cases bluish-white or fibrous, resembling a slightly-ground glass (Politzer). The manubrium remains visible or its contour is even more distinct than on the normal membrane, so long as the external layers are unaffected. In most cases such thickening of the mucous layer is complicated by circumscribed or diffuse secondary opacities of the lamina propria or of the skin.

Total opacities may also occur from a loosening and thickening of the epidermis, from swelling of the cutis layer, by which the hammer is rendered invisible, and from untransparency of the lamina propria alone. Thickenings of the epidermal layer are usually the result of the different forms of otitis externa, but are also produced by suppuration of the tympanum with perforation of the drum-membrane. From the serous infiltration and thickening of the epidermis, the membrana tympani appears grayish-white, without lustre, flattened and rough. In the highest stages of the disease the epidermis is completely macerated. Diffuse swelling of the dermis is produced by the enlargement of the blood-vessels and

the deposition of pus cells between the meshes of connective tissue; diffuse opacity of the lamina propria by translucent swelling, albuminous infiltration or fatty degeneration of the fibres of the drum-membrane, and by the deposition of calcareous molecules. Exceptionally, Politzer found an unusual number of the normal fibres constituting the histological substratum of opacities in the lamina propria.

2. *Anomalies of Curvature*

May appear as convex projections, as flattening or as increased concavity (drawing inwards) of the drum-membrane.

Convex projections, the result of inflammatory swelling with acute catarrh of the tympanum, seldom involve the whole extent of the membrane. The membrana tympani projects in the shape of a hemisphere, is bluish-red, moist and glistening, resembling the surface of a smooth polypus. With this condition of the drum-membrane, the position of the manubrium may be indicated by a groove between the anterior and posterior segments of the projection.

Partial projections of the membrane are very common from collection of exudation in the tympanum, and also during acute myringitis; they are most common near the periphery and on the upper half of the membrane, often appearing as bladder-like projections on the periphery of the posterior upper quadrant. They are also produced by granulations, infiltrations,



Fig. 35.

Bladder-like Protrusion on the Posterior Upper Quadrant; from collection of exudation in the cavum tympani.

and abscesses in the drum-membrane, by the collection of pus, mucus, caseous and epidermal masses behind the membrane, and by polypi within the tympanum.

The granulations of the membrana tympani are papillary connective-tissue growths of the cutis layer, and certain portions or even the whole membrane may be thus affected. They are more common during otitis media purulenta with perforation than during chronic otitis externa, without perforation.

The partial projections of the drum-membrane, which are sometimes produced by collections of air under its skin, and by hernial openings in the membrane, will be considered with atrophy of the membrane.

Flattening, by which the drum-membrane loses its normal concavity around the umbo, and appears as a flat disk, results, 1. From swelling of its layer of skin, which often occurs with swelling of the layer of mucous membrane; 2. From collections of exudation behind the membrane; 3. From inaction of the tensor tympani, as in fatty degeneration, atrophy, etc., of that muscle.

Increased concavity (abnormal drawing inwards, collapse, depression). A normal membrana tympani shows on dissection an increased concavity so long as the rigor mortis of the tensor tympani continues.

Pathological concavity is produced by every long continued closure of the Eustachian tube; also by synechiæ of the membrana tympani or of the manubrium with the labyrinthine wall, or with the floor of the tympanum;¹ by peripheral thickening of the

¹ By synechiæ between the drum-membrane and the labyrinthine wall, the tympanum may be divided into two parts, the anterior commu-

layer of mucous membrane and by shortening of the tendon of the tensor tympani muscle, resulting from retraction of the thickened mucous membrane which covers it.

With a pathological increased concavity, the color of the drum-membrane may remain unchanged, or it may be modified by the transmitted color of the tympanic mucous membrane, or it may be dark gray, from opacity of the drum-membrane itself. The lustre is often increased; the triangular light reflex is widened and pushed towards the periphery, and often there is a striated light reflex on the anterior lower portion of the periphery of the membrane.

The characteristics of increased concavity of the whole membrane when examined from the meatus, are perspective foreshortening of the manubrium, abnormal prominence of the short process and the axis-ligaments, more especially the posterior ligament, ligamentum mallei posticum (Helmholtz). Seen from within the central portion of the drum-membrane is funnel-shaped, and lies close to the labyrinthine wall of the tympanum.

The so-called *posterior fold* of the membrana tympani, which, when very pronounced, has been considered as diagnostic, of increased concavity, is not a true fold, but a slight angular prominence of the membrane, as the result of which a *curved projecting ridge* of membrane is found running from the short process backwards, as Von Troeltsch rightly described it in the first edition of his work (1862, S. 148).

In the natural position of the membrane, the hammer always appears, on inspection, during life, shorter and smaller than it really is. This is shown very clearly on dissection, if the membrana tympani communicating with the Eustachian tube, the posterior with the mastoid process.

pani is examined before and after removal of the meatus. In a pathological sense, perspective foreshortening is only used when there is a pathological increase in the concavity of the membrane. The perspective foreshortening is seen in its highest degree with the maximum concavity of the membrane, that is, in those cases in which the membrane lies against the labyrinth wall. With the lesser degrees of foreshortening, there is very often also a perspective diminution in the size of the manubrium, because the anterior half of the membrane is more strongly drawn inwards than the posterior half. When there is large destruction of the drum-membrane in the neighborhood of the hammer, the manubrium may lie so nearly horizontal that only the short process, with its point directed downwards, is visible externally.

For an account of partial concavities, see *Cicatrices* (p. 80), and *Atrophy of the Membrana Tympani*, (p. 85).

3. *Perforations and Cicatricial Formations.*

Perforations occur in all parts of the membrana tympani; are most common on the anterior lower quadrant of the membrane in the intermediar zone between the manubrium and the tendinous tympanic ring; are most rare immediately at the manubrium or periphery because at these spots the lamina propria is most strongly developed and offers the greatest resistance to destructive processes (Politzer). Perforations in the extreme upper portion of the membrane, in the so-called membrana flaccida Shrapneli, where there is no lamina propria, are by no means rare.

The size of perforations vary from that of a fine needle to a loss of the whole membrane. Most commonly a V shaped portion of the membrane remains above and around the manubrium and a falciform remnant on the periphery.

The most common shape of perforations is round,

oval, elliptical, or kidney-shaped. With a central perforation the exposed manubrium is drawn inwards by the tension of the tendon of the tensor tympani muscle, and lies near or directly against the promontory; in many cases it is even drawn so far inwards



Fig. 36.



Fig. 37.



Fig. 38.



Fig. 39.



Fig. 40.

FIG. 36. An old Circular Perforation of the Drum-membrane with thickened edges.

FIG. 37. Kidney-shaped Perforation.

FIG. 38. Large Kidney-shaped Loss of the Membrane, the manubrium exposed and a deposit of lime in the remnants of the drum-membrane.

FIG. 39. Loss of the whole Drum-membrane; retention of the exposed manubrium and of the tendinous ring.

FIG. 40. Loss of the Drum-membrane, the manubrium exposed and necrosed. The head of the stapes visible. In the membrana Shrapnelli is a deeply sunken cicatrix.

and upwards that on inspection from the meatus it appears to have entirely disappeared. In other cases the lower end appears to be shortened from absorption, or the whole manubrium up to the head of the hammer is wanting.

In by far the greater number of cases the perforation takes place from within outwards during otitis media purulenta, but occasionally from without inwards by perforating ulcer, or as the result of an abscess of the membrane during myringitis. Various conditions unite in producing these perforations, inflammatory softening of the tissues of the drum-membrane, pressure of the exudation behind the drum-membrane, and movement caused by expiration. At first only a rupture occurs; the edges of this then ulcerate and the loss of substance is produced. The extent of this loss of substance depends very much on constitutional conditions. The largest and most rapid destructions occur in scrofula, tuberculosis, and especially in scarlet fever.

Spontaneous atrophy, or atrophy¹ of the membrana tympani from any pressure upon it, without the existence of suppurative inflammation, is a very rare cause of perforation. When it does occur the whole drum-membrane appears extremely delicate and transparent, and the walls of the perforation are very thin. According to Beck² there is a predisposition to atrophic perforation of the drum-membrane in old age.

Fresh perforations show irregular, rough, ragged edges, old ones smooth, thinned or thickened, or occasionally calcified edges, the thickening being caused by development of blood vessels and infiltration of cells. The edges of the perforations may be partially or completely united with the mucous membrane of

¹ Schwartz, *A. f. O.*, ii., S. 291.

² Beck, *Krankheiten des Gehörorgans*, Heidelberg and Leipzig, 1827, S. 187.

the labyrinthine wall, either directly or by bands of connective tissue.

Duplicate perforations of the drum-membrane were formerly considered very rare (for instance by Politzer, "*Beleuchtungsbilder*," S. 135), but from what I have seen during life, and also on dissection, double and triple perforations, separated from each other by a bridge of membrane, are by no means uncommon. For a long time I doubted the existence of the cribriform condition of the membrana tympani such as was first described by Bonnofont, but from my own experience I am convinced that, not only in tuberculosis pulmonum and miliary tuberculosis, but also in scarlatina with pharyngeal diphtheritis and pyæmic conditions, the membrana tympani may be simultaneously perforated at different points. These multiple perforations are at first very minute, but rapidly enlarge and finally coalesce into a large opening (perhaps from emboli).¹



Fig. 41.
Double Perforation of
the Drum-membrane.

With the very marked regenerative power possessed by the drum-membrane² healing of perforations is very frequently observed. Destruction of more than two thirds of the whole membrane may be restored. In recent perforations, and in those without much loss of substance, the healing takes

¹ On multiple perforation of the drum-membrane compare C. E. E. Hoffmann, *A. f. O.*, iv., S. 277.

² I once saw a wonderful instance of this in a case in which I had excised more than two thirds of the drum-membrane and had also removed the entire hammer. After some weeks the whole opening was closed by a newly formed membrane.

place without leaving any visible pathological change on the membrane; in older and larger perforations a persistent cicatrix results. The drum-membrane becomes at first pale and dry, the edges of the perforation become thin, and with strong illumination appear to be translucent, and closure occurs from the growth of connective tissue from the edges.

Not infrequently broad bands of blood-vessels are seen running from the edges of the perforation towards the periphery of the drum-membrane, but after the closure of the opening these gradually disappear, although they may remain visible on the



Fig. 42.

Fig. 42. Oval cicatrix in the drum-membrane.



Fig. 43.

Fig. 43. Large cicatrix in the posterior half of the drum-membrane; in the anterior half is a round perforation with calcified edges and two calcified spots. (From Politzer, "Beleuchtungsbilder," etc., Taf. II., Fig. 4.)

newly formed cicatrix for a long time. The fully developed cicatrix consists of a thin stratum of connective tissue containing capillary vessels, and each side of this is covered by a very thin layer of epithelium. *The lamina propria is not reproduced*, but is seen on the edges of the cicatrix sharply defined and passing directly into concentric fibrillary connective tissue running parallel to the edges of the cicatrix. Sometimes, in certain spots, the fibres of the lamina propria pass into the cicatricial tissue and undergo a change of form.

The cicatrix, on account of its want of lamina propria, always appears to lie below the plane of the rest of the drum membrane, *i. e.*, sunken inwards nearer the wall of the labyrinth.

The size and shape of cicatrices vary according to the original loss of substance. The most usual form is oval, round, or kidney-shaped.

By inspection from the meatus they appear sharply defined, darker than the surrounding tissue and sunken inwards. On the inflation of air into the middle ear the cicatrix is pressed outwards and becomes wrinkled. Large cicatrices may lie against the long process of the incus or against the labyrinth-wall and the stapes; they may be attached to these parts either directly or by bands and membranes of connective tissue.



Fig. 44.



Fig. 45.

FIG. 44. Two very large Cicatrices in the Drum-membrane before and behind the Manubrium, throughout most of their extent adherent to the labyrinth-wall of the tympanum.

FIG. 45. Funnel-shaped retracted Cicatrix of the Drum-membrane adherent to the Labyrinth-Wall. (A diagrammatic section through the meatus, drum-membrane, and tympanum; from Politzer, "Beleuchtungsbilder," etc., S. 109.)

When the cicatrix adheres directly to the labyrinth-wall a cross-section through it sometimes shows a cavity resembling a cyst or glandular involution of the surface. The origin of these apparent changes will be considered in the chapter on the tympanum.

The external surface of those cicatrices which are attached to the wall of the labyrinth are generally moist and occasionally secrete pus, owing to an insufficient hardening of the epithelium.¹

In very many cases this desired closure of the perforation by cicatrix, does not take place, but the external and internal surfaces of the edges of the perforation unite and the opening of the membrane becomes permanent. In such cases there may be a thickening of the edges of the perforation, by a new growth of connective tissue (Fig. 36), and this may undergo calcification (Fig. 43).

An apparent, but unreal cicatrization sometimes occurs from the swollen mucous membrane entirely filling the tympanum, so that the edges of the perforation lie in contact with and become adherent to this tympanic mucous membrane. In such a case is seen a deeply sunken spot on the membrana tympani covered with thickened epidermis.

4. *Detachment of the Manubrium*

From its insertion into the drum-membrane generally takes place only at its lower end, seldom throughout its whole length; it then projects into the tympanum, and approaches, or even touches the promontory; this occurs frequently during inflammatory softening (hyperæmia and swelling) of the membrana tympani from the tension of the tendon of the tensor tympani, and is found, both with and without perforation of the membrane in the vicinity of the manubrium. In one case I saw such a detachment with a double perforation (Fig. 47). On the mucous

¹ Politzer, *l. c.*, S. 111.

membrane opposite the detached bone, a shallow groove or a slight eminence is sometimes seen. In other cases the detached manubrium appears to lie in its usual position on the drum-membrane, but can be very easily raised from it. Wendt once found a detached and separated manubrium embedded in a tubular covering of bright red, soft, smooth tissue, in which the bone was readily movable. After detach-



Fig. 46.

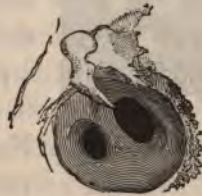


Fig. 47.

FIG. 46. Diagrammatic Section through Meatus, Drum-membrane, and Tympanum, to demonstrate the separation of the manubrium from the drum-membrane. (From Politzer, "Beleuchtungsbilder," S. 118.)

FIG. 47. Double Perforation of the Membrane with a Manubrium detached, and at its lower end atrophied. Seen from the tympanum.

ment, the manubrium may again be united to the drum-membrane by a bridge of connective tissue. No constant change in the curvature of the membrana tympani is produced by a detachment of the manubrium; the membrane may be flattened externally, or it may appear abnormally concave, or show partial projections, especially on its posterior upper part. On inspection, detachment can sometimes be diagnosticated from the fact that the manubrium suddenly disappears, perhaps just below the short process, and yet no abnormal concavity of the membrane exists.

According to Gruber the cartilaginous covering of the manubrium may be separated from the bone by

a collection of fluid between the two, but this is doubtful.

5. Abscess.

Interlamellar abscesses of the membrana tympani may occur with acute myringitis and acute catarrh



Fig. 48.

Interlamellar Abscess in the Drum-membrane.

of the tympanum, but are rare; when present they are generally multiple, and appear as slight prominences of a yellow color, and of a dull, waxy lustre. On pressure with a probe, a depression can be made in them as seen in the centre of Fig. 48. The drum-membrane is hyperæmic and swollen. They should not be confounded with the much more common partial projections of the membrane, produced by collections of secretion within the tympanum.

6. Ulceration

Seldom comes under observation on account of the slight thickness of the drum-membrane (0.1 mm.). It may be confined to the layer of the cutis in myringitis with hyperæmia and swelling, or to the mucous membrane in suppurative inflammation of the tympanum, as the precursor of perforation, or it may occur associated with perforations.

When in the cutis it appears as a shallow depression, with an uneven, rough, villous, dirty-red base which is covered with discolored detritus or crusts of dried pus.¹ The rest of the drum-membrane is softened and thickened by the inflammation.

¹ On ulcerations of the drum-membrane, compare Toynbee, *Diseases of the Ear*, p. 145. Wilde, *Practical Observations*, p. 271. Politzer, *Beleuchtungsbilder*, S. 66. Von Troeltsch, *Lehrbuch*, 4 Aufl. S. 119.

7. *Anomalies of the Membrana Flaccida Shrapneli.*

Retraction of Shrapnel's membrane may occur with or without adhesion to the neck of the hammer, the curvature of the drum-membrane remaining normal, or showing increased concavity: it is also common with a wrinkled condition or with perforation of the drum-membrane (Fig. 40). Since Shrapnel's membrane is an accessory part of the membrana tympani of no importance for the functions of the ear, its pathological changes possess but little interest. It was formerly erroneously thought by Zaufal that a funnel-shaped retraction of this membrane was pathognomonic of partial ankylosis of the hammer-incus articulation, but this appearance is often found with a perfectly normal condition of the middle ear.

Atrophy of the Drum-membrane, partial or total, is very common. The *Partial Atrophy* is caused by disappearance of the lamina propria from circumscribed affections of the mucous membrane during chronic tympanic catarrh without perforation. In appearance it is sometimes difficult to distinguish it from cicatrices, but it generally shows less distinctly defined edges than these latter.

Total Atrophy, generally of the membrana propria, is very common from long-continued closure of the Eustachian tube, which causes increased tension, and so a tension-atrophy; it is sometimes caused by masses of cerumen lying against the membrane (a pressure-atrophy). The formation of numerous radiating, straight or curved folds, with striated reflections of light, after inflation of the tympanum, are characteristic of total atrophy, as is also abnormal

mobility of the membrane under variations of the air-pressure.

With very marked atrophy, the membrana tympani sinks into the tympanum (collapse of Wilde), and the contour of the labyrinthine wall, promontory, niche of the fenestra rotunda, incus, and stapes, may be visible, together with the chorda tympani and the pouches of Troeltsch. If hyperæmia of the labyrinth-wall exists, this is readily recognized by the transmission of a violet-red color through the atrophied membrane. With the higher degrees of atrophy perforations of the drum-membrane may occur without a preceding suppuration (p. 78).

With partial atrophy of the lamina propria there are occasionally hernial protrusions of the mucosa between the separated fibres of the membrane, forming *bladder or purse-like prominences* on the membrana tympani which contain air or secretion. With a partial loss of substance in the mucosa and lamina propria during chronic inflammation of the tym-



Fig. 49.

Purse-like Projection on the Drum-membrane.

panum, it may happen that an extensive emphysema of the membrana tympani is produced by a collection of air beneath its cutis; this is particularly likely to occur from inflation of the middle ear. With this emphysema the membrana tympani presents a rough surface, and the manubrium is concealed. Usually it disappears rapidly when the air pressure ceases.

New Growths. The common *granulation-growths* have been described already (p. 74).

Epithelial growths occur both on the skin and the

mucosa of the drum-membrane. They are seen exceptionally on the skin in the form of circumscribed, hard, glistening white, pearl-like bodies, varying in size from a millet seed to the head of a pin, and are sometimes found in large numbers. They are of cartilaginous consistence, and contain a yellowish thick mass (epithelium) inclosed in a firm investing membrane; they are subject to an excentric change of position with the growth of the epithelial layer of the drum-membrane¹ just as extravasations are. Since glandular elements are wanting in the membrana tympani, these small tumors cannot be regarded as milium, which they externally very closely resemble, but may be possibly very small cholesteatomata.



Fig. 50.

Pearly Growths on the Drum-membrane. From Urbantschitsch.

The epithelial new growths on the mucous membrane are flat, round, white protuberances, only visible from within the tympanum.

Membranous, papillary, and polypoid new growths are very common on the mucosa. All the transition forms are seen, from the polypi of microscopic size attached to the mucosa by a small pedicle to complete polypoid degeneration of the whole drum-membrane. Von Troeltsch² first discovered that sometimes the fibres of the membrana propria were to be found in large numbers in polypi originating from the membrana tympani.

The *cholesteatoma* of the drum-membrane, several cases of which have been described, was once exam-

¹ First described by Urbantschitsch, *A. f. O.*, x., S. 7.

² *Virchow's Archiv*, xvii., S. 44.

ined histologically by Wendt, and found to have been developed from the endothelial sheaths of the processes of the lamina propria. The tumor was situated on the inner surface of a perforated drum-membrane, was hemispherical, bright-red, slightly knobbed, and with a bright metallic or golden lustre. It was surrounded by an investing membrane of connective tissue, a continuation of the mucous membrane; and was composed of "alternating hypertrophied processes and sheaths of the lamina propria arranged concentrically, the latter containing a deposit of cholesterine."

In the case described by Hinton¹ (sebaceous tumor), a brownish tumor, the size of a pea, consisting of a thin sack of connective tissue (possibly from the membrana tympani), and containing laminae of epithelium, was situated on the inner surface of the drum-membrane, above the processus brevis; the tumor was directly adherent to the drum-membrane; there had been no preceding otorrhoea; the tympanum contained numerous pseudo-membranous bands.

Tubercle of the membrana tympani appears in children with miliary tuberculosis as yellowish-red spots, as large or larger than the head of a pin, situated in the intermediar zones of the membrane; the remaining portions of the membrane are without injection, and of a yellowish-gray opacity, from the transmission of color from the muco-purulent exudation within the tympanum. Examined from the tympanum these spots appear flat, slightly projecting above the plane of the mucous membrane, and clearly defined. In chronic tuberculosis of the lungs in adults, I have fre-

¹ Compare *A. f. O.*, ii., S. 151.

quently seen during life yellowish, slightly prominent hard spots, which were followed by a rapid ulcerative destruction of the membrana tympani, and which were apparently tubercles of that membrane. The histological confirmation of this opinion is at present wanting.

Rupture of the Drum-membrane frequently occurs directly from injury (entrance of a foreign body), or



Fig. 51.



Fig. 52.



Fig. 53.

FIG. 51. Rupture of the Drum-membrane, from a blow on the ear. From Toynbee, "Diseases of the Ear," p. 182.

FIG. 52. Rupture of an atrophied Drum-membrane, from violent inflation by Valsalva's method. From Toynbee, *Ibid.*, p. 183.

FIG. 53. Rupture of the Drum-membrane, from a person who was hanged. Seen from the tympanum.

indirectly from air pressure (explosion, box on the ear, diving, and from whooping cough); also, from fractures of the skull, and from violent concussions of the petrous bone. The edges of a rupture from a direct wound are generally irregular, jagged, and suffused with blood; those of a rupture from indirect force almost always show a clean fissure parallel

to the radial fibres of the membrane. The ruptures which are seen in artillerists often run parallel to and behind the manubrium. When ruptures occur from a moderate air-pressure, it will usually be found that the anatomical condition of the drum-membrane predisposed thereto, atrophy or calcification having existed previously.

Simple ruptures, without deeper injury of the ear, usually heal in healthy individuals and under proper care in from a few days to a few weeks, sometimes leaving a cicatrix and sometimes not.



Fig. 54.

Fractured Manubrium.
From Roosa, "Diseases
of the Ear," 1873, p. 236.

Simultaneously with rupture of the drum-membrane, in rare cases, occurs dislocation of the hammer and incus, and in still more rare cases fractures of the manubrium. These fractures of the bone may heal, leaving very marked changes in its form, such as abnormally oblique position, contortion of its long axis, or angular position of the lower fragment.

THE TYMPANUM.

According to our present pathologico-anatomical knowledge, the tympanum is the most frequently involved in pathological processes of all the parts of the ear. The mucous-periosteal covering of this cavity is, in its normal condition, extremely thin and delicate, being only 0.75 mm. thick; it is perfectly translucent, colorless, and glistening from slight moisture; it covers, in addition to the walls of the cavity, all the ossicles, and the tendons of the *musculus tensor tympani* and *musculus stapedius*. The air cavity, inclosed by this mucous membrane, has the physiological function of furnishing a free space for the vibrations of the *membrana tympani* and the ossicles, and for the distention of the membrane of the *fenestra rotunda*.

Any changes within this space, which can produce any obstruction to the free vibration of these parts must be the cause of disturbances of hearing. The most common of these changes are large collections of secretion,¹ swelling and rigidity of the mucous membrane with the consequent diminished mobility of the conducting apparatus, destructive processes from ulceration, abnormal adhesions of parts of the conducting apparatus with each other, or with the walls of the cavity, and tumors.

Pathologically, the mucous periosteal covering of the tympanum has many of the properties of the serous membranes, although, according to its histological structure and its development, it must be considered a mucous rather than a serous membrane. Its arterial blood is obtained from several sources: the arteria meningea media, a branch of the maxillaris internus; arteria stylomastoidea and pharyngea ascendens, branches of the carotis externa; arteria auricularis posterior; arteria tympanica; and arteria carotis interna; all of which anastomose with each other.

The veins pass internally through fine openings of the fissura petroso-squamosa to the veins of the dura mater, and thence into the sinus petrosus superior, and also externally to the venous ring surrounding the drum-membrane, and to the meatus. According to Kessel, the lymph-vessels form here and there a tubular system in the periosteum, which is provided with oval expansions or lateral projections. Under the tegmen tympani, where the periosteum separates from the mucous membrane, are funnel-shaped or round lymph spaces communicating with each other and with a fine network of vessels. From the variation of air-pressure in the tympanum, the movement of the lymph in these lymph-spaces, and the system of tubes is caused (Kessel).

The connective tissue of the tympanic mucous membrane can be divided into a subepithelial and a periosteal layer. The latter gives off fibres to the tunica adventitia of the blood-vessels of the bone, and to the sheaths of the nerves which pass along the grooves of the bone, and on this account and on account of the arrangement of the blood-vessels, it can be designated as the periosteum (Prusak).

Peculiar bodies, with the structure of the Pacinian tactile-corpuscles, were simultaneously described by Kessel and Politzer as

¹ A few drops of serous fluid are very often found in the tympanum, with an otherwise normal condition of the ear.

normal attributes of the mucous membrane of the tympanum and mastoid process; by the former they were regarded as organs of special physiological importance; but later, Wendt¹ showed that they were artificial products, atrophic remains of pseudo-membranes. Von Troeltsch found similar bodies in 1859,² and described them as pathological formations; and some observers still consider them as such; for instance, Zaufal, who considers them psaumomata.

For microscopical investigation, the tympanic mucous membrane must be separated from the bone, which can be most easily done on the labyrinthine wall. It must then, for the preparation of cross sections, be hardened for some days in dilute chromic acid, then embedded in liver which has been hardened in alcohol, or in supporting liquids, as mucilage, or glue and glycerine.

Malformations. The tympanum may be replaced by a solid mass of bone. Sometimes it is only rudimentary, sometimes, on the contrary, it is enormously large. Again, the labyrinthine fenestræ may be wanting, entirely or partially. Slight changes from the normal formation of the walls are common; namely, absence of the eminentia pyramidalis, osseous narrowing of the labyrinthine fenestræ, protrusion of the lower wall with obliteration of the fenestra rotunda (Odenius).

The ossicles, all³ or any of them, may be congenitally wanting. A fusing of the three ossicles into one (columella) has been found.⁴ Michael Jaeger found a stapes with only one crus fused with the incus. Sometimes superfluous ossicles are present. A long cylindrical sesamoid bone between the malleus and

¹ According to W. Krause, they consist of concentric layers of connective tissue, without nerve-fibres and without interstitial fluid.

² *Virchow's Archiv*, xvii., S. 60.

³ Otto, *Lehrbuch der Patholog. Anatomie*, Berlin, 1830, Bd. i., S. 172. Bernard. Treviranus, Itard.

⁴ *Constatts' Jahresbericht*, 1847, Heidenreich, S. 111.

incus was found in the case of Rose¹ with atresia of the meatus, also in the case of Otto.²

Malformations in the shape of the ossicles, especially of the stapes, where they are abnormally small or large, are more common. In the stapes we may have an unequal length of its crura, or only one crus may be present (Comparetti, Cassebohm, Tiedemann, Michael Jaeger), or one crus may not reach the base, or both crura may be united by a bridge of bone, this latter malformation, according to Bonnafont, being quite common. The long arm of the incus may be more or less bent.



Fig. 55.



Fig. 56.

FIG. 55. The Stapes (*s*) has its normal base, but only one crus, which forms, with the long process of the normal Incus (*i*), one bone. On the Hammer (*m*), the manubrium and short process are wanting. The drum-membrane was also wanting. (From M. Jaeger.)

FIG. 56. Malformation of the Stapes; one crus does not reach the base. (From Welcker, "Archiv für Ohrenheilk.," Bd. I., Taf. II., Fig. 3.)

The rarest congenital malformations of shape are in the malleus. Bonnafont³ quotes one observation of congenital absence of the manubrium in a calf. Michael Jaeger found in one case of congenital absence of the membrana tympani and meatus that the head and neck of the malleus were of regular shape and in normal connection with the incus, but that the manubrium and processus brevis were wanting.

Hyperæmia and Hemorrhage. Hyperæmia of the tympanic mucous membrane in its different degrees is among the most common occurrences. Especially in childhood it may easily occur with every cold in the head, bronchitis, stomatitis aphthosa, or angina,

¹ Rose, vide *A. f. O.*, iii., S. 251.

² Otto, *l. c.*, S. 174, note 21.

³ *l. c.*, p. 538.

and may disappear again in a short time without leaving any anatomical or functional disturbances. Venous congestion may take place with disease of the heart or lungs, or with tumors of the neck, which exert a pressure on the veins of the neck. It may also occur secondarily from suppuration of the inner ear, and from meningitis by extension along the processes of the dura mater which pass into the tympanum.

The hyperæmia affects by preference the venous vessels, which become not only enlarged but tortuous and with occasional expansions.¹

Isolated *small ecchymoses* are often found with recent hyperæmia of the mucous membrane.

Extravasations of blood into the tympanum (*hæmato-tympanum*) occur through injury from severe concussion of the skull (blow, fall on the head) with or without fracture of the temporal bone;² through direct injury of the ear by the entrance of sharp substances with simultaneous rupture of the drum-membrane; through strangulation, violent vomiting and whooping cough. They may also occur spontaneously with acute inflammations, with morbus Brightii, cynanche diphtheritica, and, according to Trautmann, with endocarditis verrucosa recens and ulcerosa. The extravasation which appears through the drum-membrane of bluish-red or bluish-black color, may be resorbed or may lead to suppurative inflammation.

¹ Politzer, *A. f. O.*, vii., S. 13.

² A case of hæmatotympanum without injury of the drum-membrane, meatus or pars petrosa, from a fatal blow with an axe, is described by Casper, *Handbuch der Gerichtlichen Medecin, Thanatolog. Theil.*, S. 209, Fall 66.

Hemorrhagic infiltrations of the mucous membrane occur with congestive catarrhs of the middle ear.

Catarrhal inflammation is characterized by hyperæmia, swelling, and exudation. Although in most cases the exudation is of a mixed character, still from anatomical investigation we are justified in distinguishing (1) serous catarrh, (2) mucous catarrh, (3) purulent catarrh.

These three forms, pure and clearly defined, may occur in the tympanum, but the transition forms are much more common. To distinguish them, however, by special names, according to the character of the exudation, would be scarcely possible and practically valueless, for it would be necessary to make a large number of subdivisions, as sero-mucous, sero-hemorrhagic, muco-purulent, muco-hemorrhagic, etc.

The division into catarrhal and purulent otitis media, favored by the older authors¹ and still very commonly used, is not defensible because the first variety can pass into the second and no distinct boundary exists between the two. Perforation of the membrana tympani even is not an infallible mark of distinction.

The very highest degrees of catarrhal swelling of the tympanic mucous membrane are capable of complete retrogression, the membrane resuming its cobweb-like delicacy, and moulding itself accurately to the osseous walls and contents of the tympanic cavity. The cellular infiltration of the subepithelial connective tissue disappears by fatty degeneration and decay, and possibly, in part, by being absorbed into the lymph-vessels. For this process weeks are nec-

¹ Schlegtendal, *De Otitide. Diss. Inaug.*, Halle, 1821.

essary. In many cases, however, retrogression is incomplete, and there remain projections and duplicatures of the mucous membrane in the form of pseudomembranes or synechiæ, by which different parts of the ear are abnormally adherent or the tympanic cavity is permanently affected in its size and form.

The *serous catarrh*¹ (otitis media serosa, inflammatory dropsy of the tympanum) is the least common of the three varieties and should not be mistaken for the very common simple transudation (hydrops ex-vacuo), which results from closure of the Eustachian tube. In its acute form the membrana tympani at first appears reddened by a fine injection of its cutis layer, the tympanic mucous membrane throughout, even to the covering of the ossicles, is finely injected, and the cavity is in part, seldom wholly, filled with a clear, yellowish serous fluid which may become yellowish red from the intermixture of blood (sero-hemorrhagic). A slight swelling of the mucous membrane is sometimes caused by a watery infiltration, œdema, of the subepithelial connective tissue. The Eustachian tube may retain its normal permeability.

If the membrana tympani has not been rendered untranslucent from old opacities, it is possible both during life and after death to recognize the boundary line of the serous exudation, and its movement on a change of position of the tympanum. Sometimes, also, bubbles are distinctly visible.

In the chronic form of serous catarrh all hyperæ-

¹ Schwartze, *Paracentese des Trommelfells*, Halle, 1868. Politzer, *A. f. O.*, iii., 328. Zaufal, *A. f. O.*, v., S. 38. Wendt, *Archiv. für Heilkunde von E. Wagner*, xiii., S. 158-161.

mia is wanting, but hypertrophic processes are common in the mucous membrane, in which the ossicles may be embedded or a new growth of membranes or bands (*synechiæ*) be produced.

The serous catarrh is found especially common in old age in persons otherwise healthy; it is also found with syphilis, heart diseases, pneumonia, pleuritic exudations, Bright's disease, naso-pharyngeal catarrh, and apparently may be sometimes dependent on disturbances of vaso-motor innervation.

The *mucous catarrh*¹ (*otitis media catarrhalis*). The acute form shows a universal hyperæmia of variable degree, sometimes with hemorrhages in the subepithelial connective tissue, and swelling of the mucous membrane. This swelling may affect the whole membrane equally, or it may be more strongly marked at certain spots, the tegmen and promontory; it is produced by enlargement of the blood-vessels and hemorrhages, which press the fibres of connective tissue apart, and by a serous and cellular infiltration of the layer of loose connective tissue beneath the epithelium, numerous cells like lymph corpuscles being deposited between the fibres.

All of these changes are confined to the subepithe-



Fig. 57.

Serous Exudation in the Tympanum, the nearly horizontal boundary line of the liquid appearing through the drum-membrane.

¹ Otto, *Seltene Beobachtungen zur Anatomie*, etc., I. Heft, Breslau, 1816, S. 111. Duverney, *Traité de l'Organe de l'Ouïe*, Paris, 1683, Part iii., S. 184. Ulrich, *Ueber den Catarrh des Mittleren Ohres* (Oesterreich. *Jahrbücher*, 1847, October, November, and December). *Lehrbücher* Von Rau, Von Troeltsch, Gruber, etc. Histologically the most important are the articles by Wendt in *Wagner's Archiv*.

lial layer of connective tissue. The epithelium itself is retained. The cavity is partially or wholly filled with thick adhesive mucus mingled with a few cell elements, epithelium, mucous or pus corpuscles, red blood-corpuscles, nucleated cells and collections of nuclei; not infrequently in the dead body crystals, triple-phosphate and others, are found. Gruber¹ claims to have also found goblet-cells in the exudation accompanying mucous catarrh of the middle ear.

The consistence of the mucus may be such as to require a regular dissection with forceps and knife in order to free the walls and the ossicles. It may be either transparent or opaque (white-gray, bloody). If the whole cavity is not filled, the mucus adheres by preference to the floor and to the niches of the labyrinthine fenestræ, to the roof of the cavity on and above the hammer-anvil articulation, and on the inner surface of the membrana tympani. In the latter case the curved boundary lines of the exudation may be visible externally through the drum-membrane.

The source of the mucus is a hypersecretion of the tubular and racemose glands existing in the tympanic mucous membrane, which are found enlarged and widened into cysts near their orifices;² a part of the mucus also comes from the surface of the whole mucous membrane.

The chronic variety of mucous catarrh leads to thickening of the mucous membrane, which then as-

¹ *Lehrbuch*, S. 436.

² The round glandular cysts, ascribed by C. Krause to the normal mucous membrane, are really pathological enlargements of the normal tubular glands.

sumes a darker, bluish-gray or white appearance, and seems firmer, stronger, and more vascular than normal; the blood-vessels also become varicose. Sometimes villous prolongations and slight elevations are seen on the surface of the membrane. The thickening may be confined to certain spots, the mucosa of the drum-membrane, malleo-incal articulation, labyrinthine fenestræ, or it may be equally distributed over all portions of the membrane, and may even completely obliterate the whole tympanic cavity. With the thickening of the mucous membrane the membrana tympani appears thickened, leathery, and but slightly yielding to the touch.

In its clinical history the mucous, like the serous catarrh, is distinguished from the purulent catarrh in that it does not usually lead to ulcerative destruction of the drum-membrane. Occasionally, to be sure, it leads to slight ruptures of a drum-membrane somewhat softened by inflammation, but after the evacuation of some mucus from the tympanum, these ruptures soon heal and have no influence on the further course of the disease. Where ulcerative destruction occurs we are no longer dealing with a simple mucous catarrh, but with a combination of the mucous with the purulent catarrh.

Marked thickening from a new growth of connective tissue on the fenestræ of the labyrinth, and around the articulation of the malleus and incus are specially injurious to the conduction of sound. The niche of the fenestra rotunda may be completely closed and the ossicles may be wholly embedded in the hypertrophied mucous membrane, so that careful preparation is necessary to render them visible.

The acute mucous catarrh, *without perforation of the drum-membrane*, may unexpectedly and rapidly lead, in extremely rare cases, to sopor, convulsions, and death, from meningitis (two cases of my own, two of Wendt's).¹ In one of the cases described by Wendt, the autopsy showed extensive meningitis with abundant adherent exudation over the whole surface of the brain.

The *purulent catarrh* (otitis media purulenta) usually leads to rupture, ulceration, and loss of substance in the drum-membrane, and the discharge of the pus externally.

An exception to this rule is only found in the forms of the disease seen in nursing children, and in those cases in which there is thickening of the membrana tympani.²

A discharge of the pus towards the pharynx through the Eustachian tube is unusual.

The acute variety is very common with the acute exanthemata, typhus, tuberculosis of the lungs, and scrofula.

The exudation may be pure pus, of a yellowish or yellowish green color and creamy consistency, or it

¹ *Archiv für Heilkunde von Wagner*, xi., Fall 12 u. 13.

² Literature of Otitis Int. Purulenta Infantum: Duverney, *Tractatus de Organo Auditus*, Nürnberg, 1684, S. 36. Koppen, *Diss. Inaug.*, 1857, Marburg. Von Troeltsch, *Verhandlungen der Physikal. Gesellschaft in Würzburg*, ix., 1859. See also *Lehrbuch*, 6 Aufl., S. 404. Schwartze, *A. f. O.*, i., S. 202-205, 1864. Wreden, *M. f. O.*, 1868, No. 7, et seq. Brunner, *Beiträge zur Anatomie des Mittleren Ohres*, Leipzig, 1870, S. 31. Zaufal, *Sectionen des Gehörorgans von Neugeborenen und Säuglingen*, Oesterr. Jahrb. f. Pädiatrik, 1870, i., S. 118 et seq. Wendt, *Ueber das Verhalten der Paukenhöhle beim Fötus und Neugeborenen*, *Arch. der Heilkunde*, xiv., 1873. Kutscharianz, *A. f. O.*, x., S. 118-127, 1874, Ed. Hofmann, vide *A. f. O.*, xi., S. 81, 1875.

may contain, in addition to innumerable pus cells, granular corpuscles, and granules, a small amount of epithelium and detritus, with some mucus or blood (muco-purulent catarrh). Beneath the layer of pus the mucous membrane is bright red, deprived of its epithelium, and more or less swollen, even to a thickness of one to two millimeters or more. The greatest swelling usually appears on the roof of the cavity and on the promontory.

The swelling is due to enlargement of the blood-vessels, cellular and serous infiltration of the connective-tissue stroma, and sometimes to hemorrhagic infiltration.

In chronic cases, the disease leads to hyperplastic processes in the mucous membrane, to the formation of nodules, villous projections, papillary growths, knobbed swellings, or polypoid tumors. Only rarely does the hyperplasia of the mucous membrane fill the entire cavity. The minute granulations on the surface of the mucosa, which are composed of lymph-cells, generally contain loops of blood-vessels. In the middle layer of the mucosa there is a thick infiltration of round cells gradually disappearing towards the deeper tissues. In the periosteal connective tissue, which is the most rarely affected of all the tissues, Politzer¹ found an enlargement of the lymph-vessels, and near by round or oval microscopic cysts, with a connective tissue capsule and cellular contents. The cysts varied in size from $\frac{1}{20}$ to $\frac{1}{4}$ mm., and he considered them to be loops of an enlarged and varicose lymph-vessel.

Secondary ulceration in this disease is relatively

¹ *A. f. O.*, xi.

rare. However, from a deep loss of substance in the mucous membrane, during putrid purulent inflammation, caries may occur on the ossicula or the walls of the tympanum. If the pus is stagnant for a long time, fatty pus cells, fatty detritus and cholesterine are found; the latter particularly under the tegmen tympani, where it collects in large adherent layers; in addition to these, sometimes epithelial cells, in white laminated crusts, one half mm. or more thick, are seen. From the stagnation, drying and degeneration of the purulent masses in the antrum mastoideum, fatal resorption and infection may take place (acute miliary tuberculosis, tuberculous self-infection).

With *chronic* suppuration of the tympanum, the dura mater over the tegmen tympani is frequently diseased, being either thickened by the inflammation and abnormally adherent, or else loosened and occasionally dotted with small masses of pus.

After the healing of a chronic suppuration of the tympanum, the perforation of the drum-membrane remaining open, it will frequently be seen that the epidermis of the meatus has extended into the tympanum, sometimes even into the mastoid cells. This dermoid transformation of the tympanic mucous membrane which would without such a change be exposed to many injurious influences, affords the surest protection against a recurrence of the suppuration, and is therefore especially desirable in all cases where the defect of the drum-membrane is such that its closure by cicatricial tissue cannot be expected.

Partial *calcification* of the mucous membrane, affecting all of its layers and projecting above the normal

plane of the membrane, is an occasional result of chronic tympanic suppuration. Such calcifications of the mucous membrane are sometimes seen during life on the promontory, if there is a favorably situated perforation of the drum-membrane. Fine blood-vessels sometimes run over the spots of calcification, showing that a thin layer of connective tissue remains upon them.

Purulent tympanic catarrh may be fatal, even in adults, *without there being an externally appreciable disease of the bone*, by purulent meningitis,¹ or phlebitis of the sinuses and pyæmia;² this may occur without perforation of the drum-membrane.³ It is less common in the acute than in the chronic form of the disease. As a rule it only occurs when the drum-membrane has been increased in thickness and power of resistance by previous inflammatory processes.

Croupous and Diphtheritic Inflammation. The existence of croupous tympanic inflammation was unknown till it was very recently described by Wendt. In most cases of pharyngeal and laryngeal croup there is only a collateral hyperæmia or catarrh, either mucous or purulent, in the ear; but in several cases Wendt⁴ found a firm croup-membrane on the tympanic mucous membrane; which was swollen, much infiltrated with cells and hyperæmic.⁵ The croup-membrane also covered the ossicula.

¹ Schwartz, *A. f. O.*, i., S. 200; iv., S. 235, Fall 1.

² Gruber, *Wiener Wochenblatt*, 1862, 24, 25.

³ Von Troeltsch, *Anatomie des Ohres*, S. 70. Schwartz, *A. f. O.*, i., S. 200, ii., S. 287, iv., S. 235. Mayer, *Ibid.*, i., S. 226. Pagenstecher, *Arch. f. Klin. Chir.*, iv., S. 531.

⁴ *Archiv für Heilkunde*, xiii., S. 157.

⁵ Illustrated in *Atlas der Patholog. Histologie von A. Thierfelder*, i. Lieferung, Table i., Figs. 5-7.

With diphtheritic inflammation of the mucous membrane of the nose and pharynx, Schwartze¹ and Wendt² found only purulent and putrid catarrh in the middle ear; Wreden,³ on the contrary, reports that, in St. Petersburg, he has frequently observed, during life, a diphtheritic inflammation of the middle ear in the course of scarlet fever with diphtheritis of the nose and pharynx, occurring in children from four to fourteen years of age. From the anatomical description of the two dissections of Wreden's, it is, however, not certain that an extension of the diphtheritic process from the pharynx to the mucous membrane of the middle ear had taken place, a fact which has already been emphasized by Wendt.⁴

Küpper⁵ found with diphtheritis of the pharynx a croupous inflammation in the Eustachian tube and tympanum.

Caseous Inflammation of the tympanic mucous membrane scarcely ever exists, except in chronic tuberculosis⁶ with simultaneous miliary tuberculosis, and is never found without defect of the membrana tympani. It may also possibly occur in congenital syphilis. The purulent exudation which is mixed with desquamated epithelium loses its fluid constituents by resorption of its serum, and forms grayish-yellow or yellowish-white masses, which are generally firmly imbedded in the tissue of the swollen mucous mem-

¹ *A. f. O.*, i., S. 203.

² *Arch. f. Heilkunde*, xi., S. 260.

³ *M. f. O.*, 1863, No. 10.

⁴ *l. c.*, S. 259.

⁵ *A. f. O.*, xi., S. 20.

⁶ Joseph Hamernik, *Ueber Taubheit und Halbseitige Gesichtslähmung im Verlaufe der Tuberculose*, 1844. *Zeitschr. d. Wiener Aertze*, Sept.

brane, and infiltrate this tissue with fatty pus-cells and detritus. Rapid ulceration follows with loss of the mucous membrane, and with apparent polypoid degeneration of its tissue, and sometimes carious destruction of the neighboring bone occurs.

This caseous inflammation should not be confounded with inspissation or caseous metamorphosis of pus, which is extremely frequent in the tympanum and antrum mastoideum.

Adhesive Inflammation and Sclerosis. The tympanic mucous membrane, like the serous membranes, shows a marked tendency to *adhesive inflammation*,¹ with a new growth of vascular connective tissue in the form of membranes, bands, strings, and threads. Every form of catarrhal inflammation, serous, mucous, or purulent, may lead to these growths, but they appear to be especially common with the serous exudation. Strictly speaking, this is not a special, separate species of inflammation, but only a variety. All investigators agree on the great frequency with which these bands are found in the tympanum. Even to the older physicians their existence was not unknown (Morgagni). In 1,013 diseased ears, Toynbee found them in 202, or twenty per cent. Of the direct adhesion of the membrana tympani with the medial wall of the tympanum (promontorium), with the long process of the incus, and with the stapes we have already spoken in the chapter on the drum-membrane.² This adhe-

¹ Morgagni, *De Sedibus et Causis Morborum*, i., Epist. xiv., S. 15. Toynbee, *Diseases of the Ear*, 1860, pp. 272-275. Von Troeltsch, *Lehrbuch*. Politzer, *Beleuchtungsbilder*, etc., S. 109. Gruber, *Lehrbuch*, S. 438 and 557. Wendt, *Archiv f. Heilkunde von Wagner*, xv., S. 98. Zaufal, *A. f. O.*, v., S. 38.

² Page 74.

sion is produced by the two epithelial surfaces of the mucous membrane which lie in contact being destroyed by pressure, and then the tissue of the mucous membrane becomes changed into a vascular granulation tissue, which is subject to the usual cicatricial contraction. The union of the mucous surfaces may also take place directly by proliferation from the contiguous conical and dendriform protuberances of the membrane, and thus the apparent cysts, spoken of in the chapter on the drum-membrane, are formed.¹ These cavities are nothing more than gaps between the adherent protuberances of the two mucous surfaces (Wendt). Specially narrow tympana are particularly predisposed to such adhesive processes, as are also, in the normal cavity, those spots the least widely separated from each other (Von Troeltsch). Closure of the Eustachian tube, by causing the membrana tympani to approach the labyrinthine wall, and depression of that membrane from an external mass of cerumen lying against it, also favor these adhesive processes by narrowing the tympanic cavity.

Still more common than this direct union, with the consequent diminution in the size of the tympanum, are the so-called pseudo-membranous growths. They occur simultaneously in various forms in the same ear, and may be so numerous that the whole cavity appears to be filled with an irregular net-work. They are so common that they are found in about every fifth ear (Wendt). When recent they appear of a red or grayish-red color, soft and succulent from serous infiltration; when old, whitish-gray, or white

¹ Page 81.

and firm. Confounding them with simple stringy mucus, which is often found in similar shapes, is only possible from a very superficial observation. Openings can be seen in the pseudo-membranes, even with the naked eye; in the thread-like synechiæ they are, however, visible only under the microscope. Their situation is extremely variable; they may unite the ossicula with each other or with the walls of the tympanum; the drum-membrane with the tympanic walls, the stapes, or the long process of the incus; the tendon of the tensor tympani muscle with the roof of the cavity or the ossicula; very frequently an arm of the stapes with the walls of the fenestra ovalis. The fenestra rotunda and the ostium tympanicum tubæ may also be completely or partially covered by them, thus causing complete or partial closure of those openings.

When these adhesive processes are extensive, the tendon of the tensor tympani is almost always involved. By large membranes the tympanum may be divided into separate cavities.

An influence on the sound-conduction of the tympanic apparatus can only be ascribed to those bands which are tense and rigid, and which also bind down or touch the separate parts of this conducting apparatus, or else when they are situated on parts of special acoustic importance. On the ossicula, for instance, tense synechiæ of the stapes would be much more injurious than the same would be on the incus or malleus, on account of the minuteness of the normal vibrations of the stapes. Small synechiæ on the stapes are sufficient to reduce the hearing as much as extensive membranes between the drum-membrane and labyrinthine wall would do.

Many of these membranous bridges are not produced by pathological processes, but are the remains of the mucous tissue which fills the tympanum of the foetus and new-born child; they are the result of incomplete retrogression of this tissue, a sort of arrest of development.¹ The occasional duplicatures of the mucous membrane between the long process of the incus and the manubrium or the inner tympanic wall, and between the tendon of the tensor tympani muscle and the tympanic roof are referable to this cause.

The pathological connecting-bands are produced (1) by the contact and union of portions of the mucous membrane, when in a condition of swelling and proliferation; (2) by the formation of granulations during suppurative processes, as in ulceration of the mucous membrane or of the bone. If adhesion has taken place on one or many minute spots, the retrogression of the swelling of the mucous membrane leaves string or thread-like synechiæ, due to the drawing out and shriveling of the conical protuberances on the mucous surfaces, which have become united together. If, instead of adhesion in minute spots, an extensive surface has become adherent, membranes, instead of thread-like synechiæ, are formed. In either case, a simple duplicature of the mucous membrane is formed covered with a cubic or pavement epithelium, very deficient in cellular elements and blood-vessels, and consisting entirely of connective tissue with elastic fibres. In this connective tissue, a thin envelope of loose, wide-meshed, pliable tissue can be

¹ Hinton, *Guy's Hospital Reports*, 1863, vol. ix., pp. 264-268. Politzer, *Beleuchtungsbilder*, 1865, S. 109.

distinguished, in which a fine, slender net-work of capillaries is distributed; this is the subepithelial layer of the mucous membrane. Surrounded by this envelope are bundles of parallel, firm, tense fibres, in the form of a frame-work which incloses the coarser capillaries, and the few minute arteries and veins which nourish the tissue; this is the periosteal layer of the mucous membrane. By atrophy, and by mechanical irritation, produced by variations in the air-pressure, as by sneezing, blowing the nose, etc., membranes may become simple thread-like synechiæ, and the openings, which are frequently found in the membranes, are referable also to these same causes.

The synechiæ produced by the union of true granulations are, when recent, distinguished by the character of their tissue and by the absence of an epithelial covering.

In fully developed membranes and synechiæ of an old date, it is impossible to distinguish, either from the histological examination, or from their situation, whether they are the remains of the foetal mucous cushion, or of a pathological swelling. The latter may completely disappear without leaving any anatomical changes. If marked atrophy of the adhesions has taken place, it may be said with certainty that they date from a swelling which has long since passed away, and often that they date from the foetal tissue (Wendt).

These connecting-bands, even if quite old, share in new diseases of the ear (hyperæmia, interstitial extravasations), and suffer further changes of a regressive or progressive kind. In addition to the already described atrophy, they are subject to the deposition

of fat in the cells of the connective-tissue stroma, to sclerosis, to cicatricial contraction, to calcification, and to ossification. From all of these processes their physical characteristics may be altered so that they interfere with the conduction of sound.

(1.) *Atrophy* may cause partial or complete disappearance of the new-growths, perhaps favored by the positive air-pressure in the tympanum, which occurs spontaneously in sneezing, blowing the nose, etc., or artificially from the air-douche.

(2.) *Sclerosis*. The fibres of connective tissue become tense, and assume a parallel arrangement, become apparently thicker, and look rigid, fragile, and opaque. Here and there long spaces are formed between them, filled with a finely granular contents, which is but little altered by the addition of acids. These spaces occasionally show encapsuled cells. The fibres resemble somewhat the processes of the lamina propria.

(3.) *Cicatricial contraction* shows thickly crowded, tense fibrillæ, generally parallel, but occasionally interwoven with each other. The tissue is very firm, and with difficulty picked to pieces. The fragility and marked opacity seen in the sclerotic fibres is wanting. The fixed cells are more numerous than in sclerosis. Cicatricial thickening is found not only in the synechiæ produced from granulations, but also in the common duplicatures of the mucous membrane.

(4.) *Calcifications* occur only on the inner zone of the connective tissue, which corresponds with the periosteal layer of the mucous membrane. The lime is found deposited in molecules in slit-like spaces between the separate fibrillæ, or between bundles of

fibrillæ. These spaces sometimes appear to have a fusiform arrangement, and may be wholly filled by the lime.

(5.) *Ossification* may occur within calcified membranes in the form of separate islets or of large lamellæ. Bone corpuscles, with their processes, are seen in a homogeneous, hard, glistening stroma, which, on the addition of muriatic acid, shows no striation.

Sclerosis of the tympanic mucous membrane (induration, dry catarrh, rigidity of the tympanic mucous membrane (Toynbee), chronic periostitis of the tympanum) is a clinical designation, used by aural surgeons, which only partially describes the histological condition. Von Troeltsch, who first introduced this name into the otological terminology, wished to designate thereby only the gross appearances and the macroscopic condition of the mucous membrane, which appears thicker, stiffer, and less elastic than in the normal condition. The result of this change is rigidity of the articulations of the ossicles, and consequent increased resistance to the conduction of sound through the tympanic apparatus. The most frequent ultimate result is ankylosis of the stapes.

The histological changes which are the foundation of the so-called sclerosis are of various kinds. Only in a small proportion of the cases is there really a *connective-tissue sclerosis* of the deep periosteal layer of the mucous membrane, with cellular infiltration of the subepithelial layer; but when this does exist, the connective tissue of the deeper layer, normally arranged in fibrillæ, shows tendinous bundles, like the tendinous processes of the membrana propria. These bundles appear homogeneous, brittle, opaque, with

parallel or slightly waving fibres, and spaces between these fibres filled with a few encapsuled cells, or with a finely granular and crumbling mass (Wendt). In this condition the vessels are only few in number, and *the epithelium and subepithelial connective-tissue* may remain perfectly normal, or the latter may likewise undergo thickening.

More commonly, however, this deep periosteal layer is richly impregnated with finely granular lime-salts, with here and there spindle-shaped spaces free from the deposit, or with spots of osseous new growth, ossifying periostitis. In still other cases, according to Von Troeltsch, there is a cicatricial contraction, with thickening of a previously swollen, infiltrated, and hyperæmic tissue.

As the results of sclerosis, should be mentioned the changes which take place on the membrane of the fenestra rotunda; namely, thickenings, deposits of lime and of large round cells in its connective-tissue stroma (Wendt).

All these changes are the secondary results of chronic inflammation, and may occur after a serous, mucous, or purulent exudation, or may exist with any of these exudations. Only when this fact is borne in mind is the term sclerosis, which originated from clinical necessity, justifiable. Whether, in fact, cases of circumscribed sclerosis of the tympanic mucous membrane occur, in which the disease is wholly confined to certain limited portions of membrane, as, for instance, the fenestra ovalis, and thus producing ankylosis of the stapes, remains to be investigated histologically. From macroscopic examination such a condition can scarcely be doubted. The only ques-

tion is, whether in such cases an extensive disease of the periosteal layer of the mucous membrane, producing only at certain points gross, macroscopic changes, is not at the bottom of the trouble.

Caries of the Tympanum. Purulent catarrh of the tympanum may lead to ulceration of the mucous periosteal lining of the cavity by which the bone is exposed, and very soon attacked by the ulcerative process. In this way circumscribed caries in the tympanum occurs on the roof, labyrinth wall, and other places, but especially often on the thin osseous lamella, which separates the cavity where the head of the malleus lies from the external meatus. I have, however, seen circumscribed caries on the labyrinth wall, with simultaneous thickening of the lining membrane of the tympanum without ulceration. Carious destruction of the tympanic walls and of the ossicula is exceptional, with an imperforate drum-membrane. If the carious spot is on the wall of the labyrinth it can frequently be recognized through the perforation of the membrana tympani by the yellowish discoloration, roughness, and irregular margin of the ulcerated mucous membrane.

By perforation of the Fallopian canal, facial paralysis may be produced from the pressure of the exudation on the trunk of the nerve, or from neuritis.¹ Yet in cases where dissection shows a carious destruction of the canal, the facial paralysis during life is sometimes absent (Gruber).

Both labyrinthine fenestræ may, by caries, be fused into a single large opening in the labyrinth wall. By

¹ Tillmanns, *Ueber Facialislähmung bei Ohrkrankheiten. Diss. Inaug.*, Halle, 1869.

still greater destruction the tympanic and labyrinthine cavities may form a common cavity communicating with the posterior fossa of the skull.

After the healing of a caries of the tympanum, the perforation of the drum-membrane may close by cicatricial formation, but usually an injury of the hearing remains, the cause of which may be adhesive inflammation within the cavity; numerous cicatricial bands may unite and bind down the ossicula with each other, and with the drum-membrane and the tympanic walls.

Pathological Changes of the Ossicula and their Attachments. Carious destruction of the ossicles¹ is very common, and may occur at all ages. There may be loss of certain parts of the bones, or the bones themselves may be completely freed from their attachments, change their natural positions, form new and abnormal attachments, or be wholly expelled. The most common cause of these changes are the acute suppurative processes of the mucous membrane covering the ossicles, which occur during scarlet and typhus fevers, or else the chronic suppurations in scrofula and tuberculosis. The existence of *primary otitis* of the ossicles is also not to be denied.²

On the hammer, with extensive loss of the drum-membrane,³ there is frequently a destruction of the lower end of the manubrium.⁴

¹ Schwartze, *Sitzungsprotocoll der Section für Ohrenheilkunde auf der Naturforscher-Versammlung in Wiesbaden*, 1873, *A. f. O.*, viii., S. 226.

² *Vide* Von Troeltsch, *A. f. O.*, vi. S. 55.

³ *Vide* Fig. 40.

⁴ Carious loss in the middle of the manubrium, by which that bone is separated into two parts, occurs very rarely. Wendt found, in one case, the separated ends of the bone united by a soft, red band of tissue.

Circumscribed destructive processes on the head of the hammer, without an affection of the manubrium, are by no means rare, even without an extensive defect in the membrana tympani (Fig. 59). Circumscribed granulations on the upper portion of the drum-membrane, around the short process, would arouse suspicion that there existed such an isolated caries on the head of the hammer. The manubrium may remain in the drum-membrane, even if the head of the hammer is separated by caries and expelled (Fig. 58).

On the incus the processes may be lost, the long one first of all, and the corpus incudis then falls away from its connection with the head of the hammer; more rarely the processes remain and only the body of the bone shows carious roughness. Sometimes the incus, even with an imperfect drum-membrane, is loosened from its connections and destroyed by caries. On the stapes carious destruction is chiefly confined to the head and the crura. Not unfrequently both crura are lost, but the base usually remains in its attachments covered by a hypertrophied mucous membrane, or by a growth of connective tissue. The marked resistance of the base of the stapes to the destructive inflammatory processes of the tympanum is apparently explained by the fact that it receives part of its nutrition from the vessels of the labyrinth. I found partial destruction of the base once in a child, which died from miliary tuberculosis. While malleus and incus are frequently thrown off



Figs. 58, 59.

FIG. 58. Carious Head of the Manubrium thrown off during life.

FIG. 59. Carious Excavation on the Head of the Hammer.

during life in a state of necrosis from suppurative processes, as in scarlet fever, this is very rarely the case with the stapes. Up to the year 1873, I myself had never observed it; since then such a case has been observed by Dr. Boeck, of Magdeburg, and a short time afterwards two cases occurred in my own practice.

The case of Boeck, observed in 1867, is for other reasons remarkable, and I therefore give it: —

Wittling, a manufacturer, forty-five years old, previously healthy, and of strong constitution, as the result of exposure to a draft of air suffered, in the summer of 1866, from the usual symptoms of an acute otitis media purulenta sinistra. Disease of the bone was not suspected. On the 30th of December, he suddenly had two epileptic attacks, at an interval of half an hour. Dr. Boeck saw the second attack and describes it in the following language: "The patient was seized in the midst of a sentence, repeated the last word spoken at first slowly, then more and more rapidly for thirty or forty times; the gaze was fixed and the right hand raised; these symptoms were followed by loss of consciousness and a regular epileptic attack lasting from ten to fifteen minutes. Such attacks were repeated twice at short intervals, and never recurred afterwards. From that time the patient suffered continuously from dizziness and uncertainty of gait, so that he was unable to walk without being led. Polypoid granulations were developed in the meatus, which rapidly grew again after removal, and there was a very copious otorrhœa. On the 8th of March, 1867, while the ear was being syringed, the stapes in a perfect state was removed. Its base appeared somewhat roughened on its vestibular side when examined by a magnifying glass. The patient died from rapid consumption of the lungs on May 4, 1867. There was no autopsy.

On the malleus and incus, Von Troeltsch¹ has found a flattening due to atrophy from pressure, when the drum-membrane was strongly drawn inwards and pressed against the labyrinth wall.

¹ *A. f. O.*, viii., S. 230.

Softening of the ossicula in osteomalacia has been described by Morand.¹

In general *osteosclerosis* of the skull, as in syphilis, the ossicula are found very heavy and full.

In *injuries* from penetration of the ear, fractures of the ossicles occur, particularly in the manubrium (Fig. 54).

Loosening and separation of the articulations. The articulating capsule between the incus and stapes may become so relaxed that a sort of subluxation may occur. When the membrana tympani is strongly drawn inwards it is quite common to see the little depression on the head of the stapes lying against that membrane, giving an appearance as though the stapes was wholly separated from its articulation with the incus. The fact however is, that the incus is only pushed aside within the distended and relaxed capsule. This relaxation of the capsular band is sometimes found particularly marked with synostosis of the stapes in the fenestra ovalis (Magnus).

Complete separation of the articulations, diastasis of the ossicula, occurs most easily between the incus and stapes, as the result of purulent inflammation, which destroys and throws off the os Sylvii lying between them. The artificial diastases, produced by a careless dissection, are readily distinguished from the pathological by the healthy condition of the articulating surfaces of the ossicles, and by the fact that the os Sylvii usually remains attached to the long process of the incus. Relaxation of the firm articulating capsule between the malleus and incus seldom occurs with inflammations. I have described one such

¹ Quoted by Bonnafont, p. 539.

case, associated with superficial caries of the articulating surface of the body of the incus, and atrophy of the musculus tensor tympani and musculus stapedius.¹ I saw a similar case with Professor Zaufal, which was associated with immobility of the incus.

From injuries of the skull with fissure of the petrous bone diastasis of the ossicula may take place. In one case I saw this condition associated with a paralysis of all the muscles of the eye on the same side.

Blumenbach² asserts that hydrocephalus may be the cause of diastasis, the pars petrosa and squamosa being so separated from each other that the incus is completely separated from the stapes, and the malleus and incus remain connected with the squamous portion of the bone and are drawn downwards. In one case he asserts that he saw the stapes lifted out of the foramen ovale. I give this on the authority of Blumenbach, having had no experience of my own with this condition.

Rigidity and immobility, anchylosis, is very common in the annular ligament of the stapes and in the malleo-incus articulation.

The normal movement of the base of the stapes is very small. Helmholtz found that the excursions of the stapes were from $\frac{1}{8}$ to $\frac{1}{4}$ mm.; from this it is evident that the appreciation of the pathological impairment of mobility is extremely difficult, and the diagnosis of rigidity is often quite arbitrary. On this account Politzer has proposed to measure accurately the degree of mobility by inserting a fine manometer tube filled with a solution of carmine, air-tight, into the superior semicircular canal, and then measuring the

¹ *Archiv für Ohrenheilkunde*, ii., S. 290.

² *Geschichte und Beschreibung der Knochen*, 2 Auflage, S. 151, note 1.

variations of the fluid in the tube during changes of air pressure in the meatus.¹

The recognition of complete anchylosis of the stapes is very easy and can, if doubtful, be determined with certainty from the fact that no change occurs in the light-reflex on the membrane of the fenestra rotunda when the stapes is pressed upon, or if this light-reflex is obscured by swelling of the mucous membrane, a drop of fluid, placed in an opening made into the external semicircular canal, will answer the same purpose.

The capability of vibration in the ossicula is diminished by thickening or rigidity of the mucous membrane which covers these bones (sclerosis, calcification or ossification of the periosteal connective tissue with cellular and serous infiltration of the subepithelial layer), by synechiæ and by the imbedding of the bones in hypertrophied connective tissue (membranous anchylosis). A very common cause of rigidity of the stapes is stiffness of its annular ligament, produced by a deposition of lime in the membrane, which is often associated with similar depositions in the mucous membrane of the stapes itself and of the promontory. If the whole annular ligament, or even only the periosteal layer of the mucosa which covers it, is changed into a mass of lime, absolute immobility, anchylosis of the stapes, results. The same result is produced by a new growth of bone, hyperostosis, on the base of the stapes, on the promontory, and on the foramen ovale; by osseous bridges between the crura and the walls of the niches and by the direct pinching of the crura in a foramen ovale much narrowed by

¹ *Wiener Med. Wochenschr.*, 1862, S. 214.

hyperostosis. A predisposition to such synostosis of the stapes with the foramen ovale is produced by advanced age, possibly because at this time the cartilage covering the periphery of the base of the stapes and the edges of the foramen ovale suffers a physiological degeneration.

The existence of ankylosis of the stapes is however by no means confined to old age; but may be found at all ages, and is even sometimes congenital, the result of intrauterine inflammation.¹ I have met with it very frequently in dementia paralytica. According to Toynbee, arthritis and rheumatism are the most important factors in its ætiology. It remains to be investigated whether primary diseases, calcification and ossification, of the cartilaginous coverings of the ossicula do not, more commonly than is supposed, predispose to rigidity and synostosis.

Ankylosis of the stapes is found only exceptionally without gross pathological changes of the whole lining membrane of the tympanum. As a rule hyperæmia, thickening, and synechiæ are found together with whitish opacities on the membrana tympani.

After complete immobility of the base of the stapes has existed for a long time the crura become atrophied from inactivity, so that they break at a slight touch. This atrophy of the crura is then in marked contrast with the often clearly defined hyperostosis of the base of the bone, which may project into the vestibule, sometimes producing within that cavity a bony tumor with a convex surface.

Another secondary result, dependent on the defi-

¹ According to Gegenbauer ankylosis of the stapes is perhaps in some animals a normal condition.

cient mobility of the base of the stapes, is a new growth of cartilage in the annular ligament; this proceeds from the cartilage of the foramen ovale and is analogous to the new growths of cartilage in ankylosed joints.¹ A synostosis between malleus and incus, following a previous diastasis of the bones, was described by me.²

Malleus and incus may become ossified with the upper wall of the tympanum.

*Exostoses*³ on the ossicula, the result of ossifying periostitis, without suppuration of the tympanum and without perforation of the drum-membrane, are common on the incus, where the point of preference is on the labyrinth-side of the end of the short process; they are less common on the malleus and least common on the stapes. The space between the long and short processes of the incus was found by Wendt filled with a new growth of bone, in a woman sixty-five years of age, who had suffered from arthritis. On the end of the manubrium of a child, after suppuration of the tympanum which had left a persistent kidney-shaped opening in the membrana tympani, I once saw an exostosis the size of a small pea, possibly an ossified enchondroma. Toynbee also describes an exostosis on the manubrium.⁴ Enchondromata apparently are developed quite often on the sharply projecting processus brevis, such as is seen with a retracted drum-membrane.

¹ Compare Wendt, *Archiv der Heilkunde von E. Wagner*, xiv., S. 286.

² *A f. O.*, ix.

³ Hesselbach, *Beschreibung der Patholog., Präparate zu Würzburg, Giessen*, 1824, S. 126. Toynbee, *Medical Times and Gazette*, 1859, December, p. 589.

⁴ *Catalogue*, No. 628.

Pathological Changes of the Tympanic Muscles. Idiopathic primary diseases of these muscles are unknown; secondary changes, on the contrary, have been frequently observed with chronic inflammations of the tympanum. From long impairment of their functions as, for instance, from synechiæ between the drum-membrane and the promontory, they may undergo fatty or fibrous degeneration, or may become atrophied. True, hyperplasia of the muscles has been less commonly observed; it has, however, been found in chronic suppuration of the tympanum with perforation of the drum-membrane, polypus and caries of the ossicula (Wendt). Extravasations of blood within the muscles and hæmatomata on the tendon of the tensor tympani muscle may occur during congestive catarrh.

Shortening of the tendon of the tensor tympani may result, (1.) From connective-tissue adhesions between the tendon and its sheath, the mucous membrane covering it. This is so common that it has been described as normal by some anatomists, as Henle, but without doubt the normal condition is such that the tendon shall move freely within its sheath. (2.) From retraction of the thickened mucous membrane covering the tendon, during chronic thickening of the general tympanic mucous membrane, first described by Politzer¹ as a common result from long closure of the Eustachian tube. (3.) From membranous or thread-like synechiæ connecting the sheath of the tendon with the roof of the tympanum or with other parts of that cavity, especially the long process of the incus and the stapes. These membranous new-growths may contain osteoid deposits.

¹ *Beleuchtungsbilder des Trommelfells*, S. 132.

Destruction of the tendon of the tensor tympani is very common during suppurative processes.

Hinton found fibromata on the tendon of the tensor tympani.

Often when there is an extreme drawing inwards of the drum-membrane and partial obliteration of the tympanum the tendon is completely imbedded in the swollen and thickened mucous membrane which lines the tegmen tympani.

At the insertion of the stapedius muscle Hyrtl occasionally saw a small bony process which sometimes even projected into the body of that muscle.

Injuries. Fractures of the base of the skull often extend through the tympanic walls, and may thus afford communication between the tympanum and the labyrinth or cranial cavity.

From the entrance of sharp substances through the membrana tympani separation and dislocation of the ossicula may take place.

Foreign bodies sometimes, when the drum-membrane is uninjured, reach the tympanum through the Eustachian tube. The most common of these are minute particles of coal-soot, which under a superficial examination could be mistaken for a grayish-black pigmentation of the mucous membrane: the constituent parts of plants and hairs have also been found.

During expulsion of blood, either in hæmoptysis or hæmatemesis, blood may pass into the tympanum. Bits of food and bile may also reach the cavity during vomiting.

Foreign bodies entering the tympanum from the external meatus, after injury of the drum-membrane, may give rise to multifold nervous symptoms, and

have frequently produced fatal disease of the brain, as purulent basilar meningitis and abscess of the brain.

New Growths.

AURAL POLYPI.

Th. Wallstein, De quibusdam Otitidis Ext. Formis. Gryphiae, 1846. (Asserting the fact, first proven by Professor Baum, that ciliated epithelium is found on aural polypi). *Meissner*, Zeitschrift f. Rat. Medicin 1853. S. 350. (With a complete index of the literature.) *Wedl*, Grundzüge der Patholog. Histologie. Wien, 1854. S. 467. *Billroth*, Ueber den Bau der Schleimpolypen. Berlin, 1855. S. 27. *Förster*, Atlas der Pathologischen Histologie. S. 73. 1859. *Von Troeltsch*, Virchow's Arch. XVII. S. 40, 41. 1859. A. f. O. IV. S. 99 and 104 and Lehrbuch. *Kessel*, A. f. O. IV. S. 167. 1868. *Steudener*, A. f. O. IV. S. 199. 1868. *Lucae*, Virchow's Arch. XXIX. S. 39.

Contrary to earlier opinions, by far the greater number of aural polypi arise without doubt from the mucous membrane of the tympanum. Even in cases where they appear to have their origin in the skin of the meatus anatomical investigation shows that in reality they arise from the cavities lying above the

meatus, which are a part of the middle ear, and lined with mucous membrane (*Von Troeltsch*). Polypi vary from a microscopic size to large tumors, three or four centimeters long, which produce ulceration of the drum-membrane, fill and project out of the meatus. They may imbed and surround the hammer,¹ and in rare cases can enlarge the osseous meatus by pressure. If the



Fig. 60.



Fig. 61.

FIG. 60. Smooth Aural Polypus, the base covered with smooth papillæ.

FIG. 61. Papillary Aural Polypus resembling condylomata.

polypus projects out of the meatus the secretion quite

¹ Case by Borberg, A. f. O., vii., S. 55.

frequently produces ulceration on its club-shaped end. Often several polypi are in the same ear; it is less common to find polypi simultaneously in both ears. Spontaneous expulsion of large polypi several centimeters in length has occurred in several cases; I myself have observed one such case.

The external form of polypi is variable. We find them perfectly smooth and club-shaped on their external portions, but most of these show a papillary structure near their bases; the color of the parts of the tumor exposed to the air is whitish or grayish yellow-pink. Others again are knobbed on their surfaces from a universal papillary structure, and the color is bright red. The papillæ are either situated on a compact base of tissue, or the whole tumor consists only of branching papillæ of all sizes and forms, producing sometimes an appearance like condylomata.

The consistency of most polypi is soft; only rarely is one seen of fibromatous hardness.

All aural polypi are covered by epithelium, either by a single or multiple layer of cylinder epithelium, the upper layer of which possesses ciliæ, or by a multiple layer of pavement epithelium, or by a mixed epithelium. In the latter case the base of the tumor is covered by a ciliated cylinder epithelium and its external end by a multiple layer of pavement epithelium, arranged as in the epidermis. The transition from the cylinder to the pavement epithelium is gradual.

According to their histological structure three species of polypi can be distinguished: mucous polypi, fibromata, and myxomata.

The *mucous polypi* are the most common and are exactly similar to mucous polypi of other cavities,

being produced by a hyperplasia of the tympanic mucous membrane.

The glands which exist in them are tubular inversions of the epithelium into the tissue of the polypus: they are hyperplastic formations of the glands of the tympanic mucous membrane, which have been described by Von Troeltsch and Wendt. With these tubular glands the cystic cavities described by Meissner are almost always found; the cysts being lined with an imperfect epithelium, and filled with a mucous fluid in which loose epithelial cells and mucous corpuscles are suspended. According to Steudener they are to be regarded as retention-cysts, produced from the tubular glands. It is possible, however, that they are produced by the union of the interpapillary spaces in the same manner that they were observed to be produced on a papillary polypus of the portio vaginalis uteri by Rindfleisch.¹

Fibromata are developed from the periosteal layer of the tympanic mucous membrane, and are similar to the fibromata which develop as naso-pharyngeal polypi from the periosteum of the base of the skull. They are dense and fixed, of a pale color on account of the paucity of developed blood-vessels, are always covered by a multiple layer of pavement epithelium, and are never very markedly papillary. Into their epithelial covering small papillæ, generally single but occasionally double, project, like the papillæ of the cutis. Tubular glands and cysts are not found in these fibromata. Their structure consists of a firm connective tissue with numerous spindle or star-shaped connective-tissue corpuscles, the processes of

¹ *Patholog. Histologie*, S. 62.

which anastomose with each other. The intercellular substance is sometimes perfectly homogeneous, sometimes grossly fibrillary. In the latter case the fibrillæ are generally arranged in bundles interlacing with each other.

The existence of the very rare polypoid *myxomata* of the tympanic mucous membrane was first confirmed by Steudener, in a polypus arising by a broad base from the tympanum of a boy seventeen years old. It had been extirpated by me, and from its external appearance seemed to be perfectly gelatinous. Its epithelial covering consisted of a multiple layer of pavement epithelium into which flat papillæ, like those of the cutis, projected.

“The stroma consisted of a perfectly homogeneous gelatinous tissue crossed by an anastomosing network of spindle and star-shaped cells; very fine fibrillæ were also found, which in some parts accompanied the rows of cells, in other parts formed a wide-meshed network through the gelatinous tissue. On the surface of the tumor, and also in the neighborhood of the blood-vessels, these fibrillæ were especially numerous, in the former case in layers parallel to the surface of the tumor, in the latter case in layers concentric to the blood-vessels.”

In the gelatinous tissue, in the meshes of the network formed by the cells and fibrillæ, a moderate number of round, granular cells with a simple round nucleus, of the size and appearance of lymph-corpuscles, were found; in certain spots, these were collected together in small groups.¹

To explain the existence of this form of tumor it

¹ Steudener, *l. c.*

should be remembered that the foetal tympanum contains mucous tissue, which gradually undergoes a retrograde metamorphosis after birth. Residues of this tissue may, on the occurrence of purulent catarrh of the middle ear, which is extremely common in new-born children, become irritated and increase in size, thus producing a polypoid tumor.

It should be noticed here that a polypus arising from the promontory and projecting into the meatus, may be entirely shut off from the tympanum by a cicatricial adhesion of the edges of the perforation of the membrana tympani with the labyrinth-wall around the insertion of the polypus.

Hinton found a small *fibroma* arising from the chorda tympani and Professor Koeppé informs me that he has seen a *gumma* on the same spot.

Cholesteatoma, pearl-tumor, has already been fully described on page 22.

Exostoses occur on the tympanic walls and on the ossicles. On the floor of the cavity and on the lower edge of the promontory, they occur as normal formations, like osteophytes, in the form of sharp points and osseous bridges; but they are also found in these



Fig. 62.

Exostoses of the Labyrinth-wall, visible through a perforation of the Drum-membrane.

shapes as pathological formations on other parts, as the promontory, the neighborhood of the fenestra rotunda and eminentia pyramidalis, where they are the results of chronic periostitis. If the drum-membrane has been partially destroyed, they may be visible on inspection. Osseous bridges are sometimes found between the eminentia pyramidalis and fenestra ovalis.

Zaufal describes and figures an extensive, compact exostosis, arising from the posterior wall of the tympanum and the wall of the fossa jugularis, which had closed the fenestra rotunda and produced partial absorption of the sulcus pro membrana tympani.¹

Hyperostosis of the fenestra rotunda produces a slit-like narrowing and, in its highest degrees, complete closure of this opening, as was well known to the older observers.² If the hyperostosis of the tympanic walls is equally distributed a marked narrowing of the tympanum results.

Cysts. A retention-cyst lined with epithelium and filled with rhombic tables of fat-crystals has been described by me ;³ it was apparently developed from a tubular mucous gland of the tympanic mucous membrane. Politzer⁴ has seen cyst-like formations arising from the mucosa of the drum-membrane, "consisting of a sack with thick fluid contents." Toynbee and Hinton have described cases of sebaceous tumors or dermoid cysts,⁵ containing hairs.

Epithelial cancer, arising primarily from the tympanum, is extremely rare.⁶

Osteosarcoma of the tympanum reaching into the meatus has been observed by Wilde,⁷ Toynbee,⁸ and Boeke.⁹

¹ *A. f. O.*, ii., S. 48.

² Cassebohm, *De Aure Humana*, Halæ, 1734, S. 39. Cotunni, *De Aquæductu*, Viennæ, 1774, S. 132.

³ *A. f. O.*, i., S. 205.

⁴ Vide *A. f. O.*, v., S. 216.

⁵ *Transactions of the Patholog. Society*, xvii., pp. 274, 275.

⁶ Vide page 26.

⁷ *Pract. Bemerkungen über Ohrenheilkunde*, Uebersetzung, S. 244, 433.

⁸ *Diseases of the Ear*, p. 386.

⁹ *Wiener Med. Halle*, 1863, No. 54.

Tubercle. The existence of miliary tubercle in the tympanic mucous membrane of man has not been proven anatomically with certainty. I have frequently observed during life small, gray, miliary nodules on the inflamed and swollen mucous membrane of the inner tympanic wall during the purulent otitis of tuberculous children; these I was inclined to regard from their gross appearances as tubercles. In my anatomical investigations I have as yet sought them in vain.

In the pig the frequent occurrence of tuberculosis of the middle ear has been confirmed by Schütz.¹

EUSTACHIAN TUBE.

Wendt, Krankheiten der Nasenrachenhöhle und des Rachens. (*Ziems-sen's* Handbuch der Spec. Pathologie und Therapie, Band vii., S. 235-323, 1874. *Moos*, Beiträge zur Normalen und Pathologischen Anatomie und zur Physiologie der Eustachischen Röhre. Mit 18 Abbildungen. Wiesbaden, 1874. Lehrbücher von *Toynbee*, *Von Troeltsch*, *Gruber*.

General Remarks.

The Eustachian tube in man is closed, when at rest, by the slight contact of its walls. It is, however, a condition of normal hearing that the canal should be from time to time opened in order that the differences of air-pressure between the tympanum and the atmosphere may be equalized by the so-called ventilation of the tympanum. Every long-continued closure of the tube at any point of its course by swelling, collection of secretion, or insufficiency of the musculus dilatator tubæ sive tensor veli palatini results, when the drum-membrane is imperforate, in a gradual absorption of the air within the tympanum; the drum-membrane, with its appendages, then sinks inwards, owing to the over-pressure of the atmosphere, its tension is increased, and a hyperæmia ex vacuo occurs in the tympanic mucous membrane. As the result of this hyperæmia, a transudation or serous exudation next takes place, and this is fre-

¹ *Virchow's Archiv*, Band 66, S. 93.

quently followed by swelling of the tympanic mucous membrane and abnormal adhesions between the drum-membrane, its appendages, and the tympanic walls. As the Eustachian tube in children is absolutely wider and shorter than in adults, it would in childhood less commonly and easily become closed were it not that the form of the pharyngeal orifice in children is slit-like, while in adults it is widely open; and this form of the pharyngeal orifice furnishes a predisposition to closure of the tube whenever the mucous membrane of the naso-pharynx is swollen. The shape of the pharyngeal orifice is subject to individual variations; it is in adults by no means always funnel-shaped, but often a triangular or crescentic open fissure; its average distance from the posterior end of the lower nasal cartilage is, according to Luschka, 7 mm. The width of the canal is, in adults, subject to very great individual differences: the average diameter is, for the isthmus, 2 mm. high and 1 mm. wide; for the pharyngeal orifice, 8 mm. high and 5 mm. wide; for the tympanic orifice, 5 mm. high and 3 mm. wide.

The mucous membrane of the canal is somewhat projecting at the pharyngeal orifice, but at other points is, in the normal condition, smooth, firmly adherent to the tissues beneath, not easily torn, and of a light yellow color. The valve of the tube, a valve-like duplicature of the mucous membrane, which was described as a normal formation at the pharyngeal end of the canal, by Koellner¹ and the older anatomists, is pathological, and due to a relaxation or wrinkled swelling of the mucous membrane. Recently the same thing has been described by Moos² "as a prominence, a true valve, which, although varying in different individuals, is never absent in the normal condition."

The mucous membrane in the osseous portion of the tube corresponds in its pathological changes with the tympanic mucous membrane, except that membranous new growths are less common in the tube than in the tympanum; the membrane in the cartilaginous tube, however, conforms, as a rule, with the condition of the mucous membrane of the naso-pharynx. And also just as there exists a cystogenous, adenoid tissue, with numerous scattered lymph-follicles directly beneath the mucous membrane on the roof of the

¹ *Reil's Archiv*, ii., S. 18.

² *Beiträge zur Anatomie und Physiologie der Eustachischen Röhre*, Wiesbaden, 1874, S. 29.

naso-pharyngeal cavity, passing transversely from one tubal orifice to the other, and also on the tubal prominence and in the cavity of Rosenmüller, so also there is in direct continuity with this tissue at the pharyngeal orifice of the Eustachian tube a layer of cystogenous substance, of variable thickness, beneath the ciliated cylinder epithelium. This adenoid tissue is subject, especially in childhood, to great hyperplasia, causing narrowing and closure of the orifice of the tube. In old age this same tissue is subject to atrophy. The mucous membrane, between the tubal prominence and the choanæ, is normally of a rather paler, more yellowish color than the rest of the mucous membrane.

Malformations. Congenital absence of the Eustachian tube was observed by J. Gruber,¹ in one case associated with absence of the meatus, ossicula, and a rudimentary development of the tympanum and labyrinth. Cases of congenital obliteration and stenosis are also very rare; one case is recently described by J. Gruber,² which was associated with cleft palate. Congenital widening of the tube to three or four times its normal calibre is described by Cock.³ Congenital anomalies of the tube, in the form of *angular bends*⁴ in its osseous portion, of ossification-gaps in the wall of the canalis caroticus, of unsymmetrical position of the pharyngeal orifices, are more common.

Hyperæmia and Hemorrhage. Hyperæmia in the tubal mucous membrane occurs of all degrees, from a slight net-like injection to a uniform scarlet or brown-red color. With simultaneous hyperæmia of the pharynx, it is most marked in the cartilaginous portion

¹ Vide *A. f. O.*, ii., S. 154.

² *Lehrbuch der Ohrenheilkunde*, S. 573, with an illustration.

³ *Med. Chirurg. Transactions*, London, vol. xix., p. 161.

⁴ The median wall of the osseous tube may show depressions two mm. or more in depth, and, as the lateral wall does not follow this curvature, a sudden dilation of the tube at these points is then produced.

of the tube, gradually diminishing in intensity towards the tympanic orifice. Just the opposite is the case with simultaneous hyperæmia of the tympanum. If the hyperæmia of the pharynx extends into the cartilaginous tube, rhinoscopic examination during life, and also the autopsy, often show the ostium pharyngeum tubæ surrounded by a tissue of enlarged veins, which can be followed into the tube. Dissection, in such cases, shows also a decided injection, with increased secretion, higher up the tube. Not infrequently a decided hyperæmia of the pharynx will be found to cease just at the edge of the tube.

Hæmorrhages are found in the form of ecchymoses in the tissue of the mucous membrane and as large flat extravasations. If the exudation is situated at the ostium pharyngeum the opening may be closed as with a plug. Gray and grayish-black pigmentations of the pharyngeal mucous membrane are sometimes seen to extend into the cartilaginous tube. Large amounts of coagulated blood are sometimes seen in the tube after fracture of the base of the skull and after hæmoptysis and hæmatemesis.

Inflammation. The catarrhal inflammation of the Eustachian tube is characterized by hyperæmia, increased secretion and swelling of the mucous membrane. An abundant collection of mucous secretion is found very often on dissection, not unfrequently so much that it appears to fill the whole calibre of the tube. In this mucus many loose ciliated epithelial cells are mixed. If the mucus is thick and adhesive it may form distinct masses which project from the pharyngeal orifice as the mucous masses do from the os uteri; such masses may also firmly close the

osseous tube when the cartilaginous tube is empty. These masses are of a jelly-like consistency and may be connected with similar masses in the tympanum.

The cause of the swelling in the mucous membrane is hyperæmia and serous infiltration, and also an increase in the lymph-like elements of the subepithelial tissue (cellular infiltration) which are most numerous at the pharyngeal end of the canal. By a specially large collection of these cells at certain spots, hyperplasia of the gland follicles, a granular appearance of the mucous membrane, is produced. There is also in chronic cases a marked projection and wrinkling of the mucous membrane perpendicular to the axis of the canal, with hypertrophy of the glandular layer and thickening of the submucous connective-tissue. Great swelling is found most commonly at the ostium pharyngeum, which is then changed to a mere slit; higher up the tube it is more rare and is least common in the osseous tube. In the latter situation, however, a granular appearance of the mucous membrane caused by the formation of small cells may occur, with simultaneous analogous changes in the tympanic mucous membrane, or the layer of submucous connective tissue may be hypertrophied.

The existence of a genuine *croupous inflammation* in the mucous membrane of the tube during croup of the larynx and pharynx has been certainly proved by Wendt.¹

In *variola*, according to the same author, peculiar changes of the epithelium with the formation of cavities of variable size and form and filled with pus cells, take place very commonly at the pharyngeal orifice

¹ *Archiv der Heilkunde*, xi., S. 261.

and less commonly higher up, along the lower third of the tube.

Traumatic inflammations of the Eustachian tube sometimes occur after surgical operations in the naso-pharynx, from incisions into the tubal orifice during resection of the upper jaw, etc.

Secondary changes of the tubal cartilage, in the form of small spots of ossification, have been described by Moos.¹

Calcifications of the tubal cartilage also occur with chronic inflammation of the middle ear.

Ulceration at the ostium pharyngeum and extending from here into the lower end of the cartilaginous tube is found in syphilis, tuberculosis, scrofula, diphtheritis, and variola.² I have frequently observed with the rhinoscope on the tubal prominence and at the entrance of the pharyngeal orifice small, round, superficial *follicular ulcerations*, the result of purulent follicular catarrh of the naso-pharynx. In caries of the temporal bone with destruction of the osseous tube *ulcers from erosion* are seen on the ostium pharyngeum if the foetid pus flows into the pharynx in large quantities. The ulcers in variola are always superficial, usually of a round form, more common on the sides than on the floor and medial surface of the pharyngeal orifice, but they may, however, change the whole ostium pharyngeum into a flat ulcerated surface. They rarely extend to the lower third of the cartilaginous tube.

¹ *l. c.*, p. 49.

² According to Seidl the ulcerations of typhus may occur in the tube. *Wiener Med. Wochenschrift*, 1852, Nos. 2, 5, 6. *Ueber den Einfluss des Catheterismus der Eust. Röhre.*

The ulcers in syphilis and tuberculosis which extend from the pharyngeal mucous membrane are much deeper, reaching the cartilage itself and even penetrating its substance. On the edges and in the neighborhood of tuberculous ulcerations of the tubal prominences Wendt¹ has found formations of fresh miliary tubercles.

An extensive tuberculous ulceration which I have preserved in my collection, taken from a man thirty-three years old, extends to the middle line of the fornix and the posterior pharyngeal wall, involves the cavity of Rosenmüller, which is changed into a large excavation twice as deep as the cavity on the opposite side, and has destroyed the greater part of the tubal prominence. The mucous membrane of the lower portions of the tube was hyperæmic and swollen, but without ulceration. In addition there was double perforation and purulent infiltration of the drum-membrane, and the tympanic mucous membrane was greatly swollen, and infiltrated with pus. The articulating connections of the ossicles were loosened.

Syphilitic ulcerations on the tubal prominence and at the entrance of the pharyngeal orifice, with ulcerations on other parts of the naso-pharynx as the septum narium, choanæ, fornix, posterior wall of the uvula, can often be recognized by rhinoscopic examination, where the usual inspection of the pharynx without a mirror would raise no suspicion that an ulcerative process existed.

Higher up in the tube, ulcerative processes only occur with caries and tumors (epithelial cancer),

¹ *l. c.*, p. 297.

which may partially or wholly destroy the osseous tube.

Contraction and Enlargement. *Contraction* or stenosis of the Eustachian tube, even to complete closure, takes place from swelling of the mucous membrane or thickening of the submucous connective-tissue in catarrh, from hyperplasia of the cystogenous tissue at the pharyngeal orifice, from œdema of the tubal prominence during congestion of the vena cava superior, from cicatricial formations in the naso-pharynx, and at the ostium pharyngeum, from hypertrophic thickening of the soft palate, by which the anterior lip of the tube may be pressed against the posterior lip,¹ from insufficiency of the palato-tubal muscles in congenital or acquired fissure of the palate and in cleft palate, from closure of the ostium pharyngeum by new growths in the naso-pharynx, such as naso-pharyngeal polypi, large cysts, cicatricial bands, hyperplastic pharyngeal tonsils,² great swelling of the lower nasal-cartilage,³ or great hypertrophy of the

¹ Von Troeltsch, *A. f. O.*, iv., S. 136.

² The pharyngeal tonsils (*glandulæ pharyngææ*) undergo, especially in childhood, and more rarely between the ages of twenty and thirty, a hyperplasia so that they assume a ragged, almost polypoid appearance. In the higher degrees of this hyperplasia they may reach more than a centimeter above the upper part of the vomer and directly cover the orifice of the tube. By compression this orifice may be narrowed to a mere slit. If, at the same time, there is hyperplasia of the cystogenous tissue of the tubal prominence, this prominence appears as a soft fold $\frac{1}{2}$ cm. thick, and with a ragged edge projecting into the naso-pharynx. Adhesions of the hyperplastic *glandula pharyngea* with the tubal prominence may also exist.

³ The posterior edge of the lower nasal cartilage is often enormously thickened and lengthened posteriorly; it then appears ragged, notched, or fringed. It may then reach the orifice of the tube, and project over and partially lie upon this orifice. The irritation resulting from this produces hyperæmia and hypersecretion which extends usually as far as

palatine tonsils.¹ Stenosis from hyperostoses and exostoses, with or without osteosclerosis of the skull, or from new connective-tissue growths at the tympanic orifice, as in caries or hyperplastic catarrh of the tympanum, is much less common.

Stenosis in the middle portion of the canal appears to be extremely rare. It is in practice, from inexact observation, thought to be much more common than it is in reality. Not infrequently an angular bend in the course of the tube or a projection of the carotid canal into the osseous tube is mistaken for stenosis, on attempting to pass a bougie. Real strictures, in the sense in which urethral strictures are formed by thickening and atrophic shortening of the tissues, appear not to occur in the Eustachian tube. In the osseous tube, however, contractions from hypertrophy of the connective-tissue layer of the mucosa, sometimes with deposits of lime, occur.

Contractions at the ostium tympanicum are frequent in otitis media, produced by hypertrophic mucous membrane which forms a fold or valve-like elongation of the tissue, or else by a new growth of connective-tissue, which also fills the anterior part of the tympanum; this new tissue, when of recent growth, is succulent and red, when old is grayish white and firm. Thread-like bridges of tissue also occur across the ostium tympanicum (Von Troeltsch,² Magnus³).

the osseous tube (Von Troeltsch, *A. f. O.*, iv., S. 139). Cystogenous tissue exists normally in the mucous membrane, which projects from the lower nasal cartilage.

¹ In extreme hypertrophy of the palatine tonsils the arcus pharyngo-palatinus, or even the whole palate, may be pressed against the ostium pharyngeum. (This is denied by Wendt.)

² *A. f. O.*, iv., S. 111.

³ *A. f. O.*, vi., S. 258.

An osseous stricture of the tube, three mm. long, and one cm. below the ostium tympanicum, was seen and figured by Toynbee.¹ A bristle could scarcely be passed through it.

The canalis caroticus may project so far into the osseous tube as to almost close its calibre. I have also frequently seen the carotid artery separated from the tube merely by a thin, transparent lamella of bone.

In *atrophy* of the mucous membrane of the nasopharynx, the ostium pharyngeum appears unusually wide open and deep. The tubal prominence then projects very much, and from the thinning of its mucous covering appears almost bare.

Acquired *enlargement* of the canal throughout its whole extent is frequent in connection with sclerosis of the tympanic mucous membrane. The canal may be enlarged to three or four times its normal calibre. Partial enlargement in the osseous portion, due to atrophy of the osseous walls, is found after chronic suppurations of the tympanum.

According to Rüdinger² in the bodies of old persons, an abnormal gaping of the tube *throughout its whole length*, with an atrophy of the musculus dilatator tubæ, is frequently seen.

Adhesions, from adhesive inflammation or hyperostosis, may occur at both orifices of the tube, but are rare in the canal itself. Cicatricial adhesions of the ostium pharyngeum occur from syphilitic ulcerations in the naso-pharynx. The cicatricial tissue

¹ *Monthly Journal*, August, 1850 ; *Medical Times*, February, 1850, p. 143.

² *Monatsschrift für Ohrenheilkunde*, 1868, No. 9.

closes the orifice, usually after destruction of the whole limbus cartilagineus and adhesion of the palate to the posterior wall of the pharynx. The number of these cases as yet described is not large.¹ After diphtheria, variola,² and scrofula, cicatricial closure of the pharyngeal orifice has been observed. A case of the latter form occurred in Halle in January, 1873.³

A boy twelve years old died from stenosis of the trachea caused by a cicatrized ulceration, directly above its bifurcation. The lungs were free from tubercles. The naso-pharynx was reduced to the size of a small hazel-nut. The firm cicatricial tissue which closed this cavity from the mouth, by the adhesion of the soft palate to the posterior wall of the pharynx was enormously thick, reaching, close to the vertebral column, a thickness of two centimeters. On the edge of the hard palate in the median line was a very minute opening surrounded by white cicatricial edges. The choanæ were of normal width, the mucous membrane slightly thickened, the cavernous tissue on the posterior portion of the lower nasal cartilage very much hypertrophied; the ostium pharyngeum of the right tube completely obliterated by cicatricial tissue; that of the left tube narrowed to one millimeter; both drum-membranes very much drawn inwards; tympana and mastoid cells on both sides completely filled with a sero-mucous, perfectly clear exudation. During life such a degree of deafness existed that it was necessary to shout directly into the ear.

Adhesions from growths of connective tissue at the ostium tympanicum are frequent with caries of the temporal bone, and after the cessation of suppuration of the tympanic mucous membrane. Bridges of

¹ Otto, *Patholog. Anatomie*, Breslau, 1814, S. 184. *Seltene Beobachtungen zur Anatomie*, etc., Breslau, 1816, S. 3. Virchow in *Virchow's Archiv*, xv., S. 313. J. Gruber, *Statistischer Bericht von 1863*.

² Lindenbaum, *A. f. O.*, i., S. 295. According to Wendt, deep destructive processes and adhesions are not found in variola. (*Krankheiten des Nasenrachenraums*, S. 285.)

³ Already published in Volkman's *Beiträge zur Chirurgie*, Leipzig, 1875, S. 305.

connective tissue within the tube itself are found in great variety; they were found three times in the cartilaginous tube by Wendt, and had already been described in three cases by Toynbee.¹

Wever² describes an adhesion throughout the whole length of the tube produced "by a fibrous substance, which was firmly united with the mucous membrane."

New Growths. Polypi within the tube have been described in a few cases. The most noteworthy case is that of Voltolini,³ where the polypus filled the whole tube like an earth-worm and had produced an enlargement of its calibre.

Large tympanic polypi, fibromata, often have one of their attachments in the ostium tympanicum. Cases are also known where their only insertion was in this orifice. Smaller polypoid tumors frequently occur in the osseous tube.

In syphilis excrescences like the pointed condylomata are sometimes seen at the ostium pharyngeum; in miliary tuberculosis caseous nodules are sometimes seen at the same spot.

Exostoses, in the form of osteophytes, are frequently found in the Eustachian tube with similar growths in the tympanum.

Foreign Bodies. During the act of vomiting particles of food sometimes pass into the tube. Other foreign bodies scarcely ever get into this canal, except those introduced for surgical purposes and accidentally left in, such as broken bougies, etc. The case of

¹ Translation by Moos, p. 221.

² *Diss. Inaug.*, Freiburg, 1835, S. 13.

³ *Virchow's Arch.*, xxxi., S. 220.

Fleischmann¹ is well known, where he found, during dissection, a grain of barley deep in the tube. Andry² once found an ascaris in the canal.

Pathological Changes in the Tubal Muscles. Fatty degeneration and atrophy of the tubal palatine muscles are the frequent results of chronic retro-nasal and tubal catarrhs. In trichinosis the tubal muscles are constantly very abundantly infiltrated with the parasite, while the two tympanic muscles appear to always remain free from them.

A muscular hypertrophy of the musculus tensor veli palatini vel dilatator tubæ has been described by Moos³ as the result of chronic tubal catarrh.

Extensive hemorrhagic infarcts also occur in the tubal muscles (Zaufal).

MASTOID PROCESS.

Zajá, Processus Mastoideus und dessen Zellen. Ann. Univers. 188. S. 241. Maggio, 1864. (Auszug von Theile in Schmidt's Jahrbüchern. Bd. 125. Heft i. S. 33.) Schwartz and Eysell, Ueber die künstliche Eröffnung des Warzenfortsatzes. A. f. O. VII. S. 157. 1873 et seq. Buck, Diseases of the Mastoid Process. Archiv für Augen- und Ohrenheilkunde, III. 1. 1873. 2. 1874. Wendt, Archiv für Heilkunde von Wagner. XIII. S. 424-427.

The lining membrane of the air-cells of the processus mastoideus, the communication of which with the tympanum Valsalva first demonstrated,⁴ and Sappey afterwards named the canalis petromastoideus, is a direct continuation of the mucous membrane of the tympanum, and is subject to the same pathological changes as the tympanic mucous membrane. It possesses, however, no ciliated epi-

¹ Linke's Sammlung, Band ii., S. 183.

² Itard, *Krankheiten des Ohres*, Weimar, 1822, S. 94.

³ l. c., p. 47.

⁴ *De Aure Humana*, 1707, p. 17. According to Buck the passage from the tympanum to the antrum mastoideum is sometimes double (l. c.).

thelium. In the antrum mastoideum, exactly the same pathological condition is almost always found as in the tympanum, while the rest of the mastoid cells may remain free from disease or, at least, the changes in them are not of the same intensity and form as in the tympanum. From the unequal development, and variable relation of the solid to the spongy osseous substance in the mastoid process, it is sometimes difficult to decide in a given case whether we are dealing with a pathological or physiological appearance.

Primary and isolated disease of the mastoid occurs but very rarely; secondary disease is common from diseases of the tympanum and meatus. In childhood caries and necrosis is generally confined to the mastoid process, while in the tympanum only purulent catarrh occurs.

Malformations. Complete absence of the process is found together with other malformations deeper in the temporal bone, in congenital deafmutism.

The external form and size of the mastoid process is extremely variable. Wildberg¹ found its point curved like a beak, resembling in appearance the processus coracoideus of the scapula.

The size and form of the mastoid cells are subject to great variations; even in the two processes of the same individual, they seldom correspond. In six hundred skulls, Hyrtl² found that in three the occiput helped form the cells. The antrum mastoideum is the only large cavity, which is constantly present; in a child this lies very superficially, directly behind and above the external meatus.

In the cortical substance of the bone, which is normally from two to six millimeters thick, thin spots or congenital *ossification gaps* may exist, sometimes of such a size that the point of the little finger can

¹ *Versuch einer Anat. Physiol. Pathol. Abhandl. über die Gehörwerkzeuge des Menschen.* S. 14, note h.

² *Wiener Med. Wochenschrift*, 1860.

be passed into them. The openings may be the cause of an emphysema of the skin behind the ear.

Separation of the mastoid from the rest of the temporal bone, was seen several times by Meckel.

Hyperæmia and Hemorrhage. Diffuse hyperæmia of the mucous lining of the mastoid is common with simultaneous hyperæmia of the tympanum, and may be of any degree, from a yellowish red to a bluish black color.

Hemorrhages are found in the form of hemorrhagic infiltration of the mucous membrane, and of effusions of blood on the surface of the mucous membrane, especially during typhus, and after injury, such as a blow on the head or fracture of the skull.

Catarrhal Inflammation of the Pneumatic Cells of the Bone. The swelling and thickening of the mucous-periosteal lining of the antrum and mastoid cells may *completely fill* these cavities, if they are of small size. The mucous membrane then assumes from serous infiltration a succulent, gelatinous appearance, and the osseous cavities, which in their normal condition should contain air, appear to be filled with a red pulpy mass. The communication of the antrum mastoideum with the tympanum may thus be completely obliterated or only be retained through a narrow slit. Where the swelling is of a lesser degree the unoccupied space may be wholly or partially filled with exudation, either serum, mucus, or pus. In most cases the tympanum is at the same time inflamed, but an independent inflammation may occur in the cells without extending to the tympanum and without perforation of the drum-membrane. From an oral communication I have learned of a dissection of a case of

Professor Zaufal's in which an isolated suppuration in the mastoid cells took place without caries, and without extending to the tympanum, and led to phlebitis of the sinuses and death.

Wendt found, in a case of croup of the whole middle ear, which came on during variola, true croupous membrane also in the mastoid cells, together with abundant cellular infiltration of the connective-tissue stroma of the mucous membrane.

As the result of chronic catarrhal inflammation within the cells, pseudo-membranes are often formed by which the communication with the tympanum is closed. These pseudo-membranes, by shutting in a number of the osseous cells, may produce large cystic cavities filled with a serous or mucous contents. In these new formed membranes calcifications and ossifications may take place just as in the membranes within the tympanum. From the retention of pus in the mastoid cells crystals of cholesterine may be formed, often in large masses, together with granular corpuscles, fluid fat, and detritus.

Periostitis Externa. The external periosteum of the mastoid is sometimes attacked by primary inflammation without the cavities of the middle ear being diseased. In these cases pus may collect between the periosteum and the bone, superficial necrosis of the cortical substance may follow, the periosteum after being loosened may rupture and a subcutaneous abscess result. The periostitis may extend to the posterior upper wall of the meatus,¹ which then always shows during life redness and swelling.

Such a primary periostitis externa is rare compared

¹ Preparation in the Collection of Professor Zaufal.

with the great frequency of secondary periostitis associated with caries and necrosis of the mastoid cells.

The separation of the periosteum from the bone by a collection of pus, unless extensive, does not always lead to necrosis.

Suppurating lymph-glands over the mastoid process, glandulæ subauriculares, with fistulæ beneath the skin, should not be confounded with periostitic abscesses. Suppuration of the parotid may produce fistulæ, which may extend even to the mastoid region, without the bone becoming affected by the suppurative process.

Caries and Necrosis is more common in the mastoid than in any other part of the temporal bone. It is most frequent in childhood, on account of the anatomical relations of the bone, which are highly favorable to the retention and consequent inspissation and putrefaction of the pus formed in suppurative inflammation of the mucous-periosteal lining of the mastoid cells. If during the inflammation ulceration takes place, the bone, deprived of its periosteum, is very soon involved in the molecular necrosis of the tissues, producing caries.

With caries of the mastoid process the posterior wall of the meatus is almost always deprived of its periosteum and perforated.

Not unfrequently, if large portions of bone have become gangrenous from interference with their nutrition, large perfectly loose sequestra are found within a carious cavity of the mastoid which is nearly filled by granulations; the cortical substance of the bone remains firm. In such cases of central necrosis of the mastoid the disease of the mucous periosteal lin-

ing of the cells, and not a periostitis externa, is the cause of the necrosis. If the putrid pus does not find a sufficient exit into the tympanum a fistulous opening through the osseous walls is formed, and thus a drainage-canal produced. Such a fistula in the cortical substance may exist without the skin over the mastoid showing any perceptible change. Occasionally such an opening becomes filled with granulations



Fig. 63.

Central Caries Necrotica of the Mastoid Process. Loose sequestrum within the cavity. The corticalis perfect.

which will simulate fluctuation, and yet an incision will show that there is no pus.

These fistulæ generally open through the skin on the external surface of the mastoid, or through the posterior upper wall of the external meatus, less commonly through the lower portion of the mastoid, when the pus may gravitate into the neck and lie quite deep; they may, however, also open into the posterior or middle fossa of the skull, and thus produce fatal secondary disease, as meningitis or phlebitis of the sinuses with pyæmia. The dangerous proximity of the sinus lateralis, whose osseous wall is often perforated by caries, is of special importance in this connection.

Before the fistulæ break through the skin, abscesses form behind or below the auricle or in the meatus. These may extend even to the middle line of the occiput, or following the course of the deep fascia of



Fig. 64.

Loose Sequestrum in the Mastoid Process seen through a large carious opening (*b*) in the Corticalis. At (*a*) is a carious opening in the posterior wall of the meatus communicating with the cavity of the mastoid. At (*c*) is a carious opening on the lower side of the pars mastoidea. (From Kuh, "Klinische Beiträge," etc., Breslau, 1847.)

the neck may even reach the pleura. Minute sequestræ may disappear very slowly by resorption through the granulations. The presence of sutures on the sequestra often determine exactly the locality from which the bone has been thrown

off. After the expulsion of a sequestrum through the fistulæ, or after its removal artificially, the natural healing often takes place wonderfully rapidly if the individual is free from dyscrasiæ, the whole cavity in the mastoid filling with granulations which are gradually transformed into ossified connective tissue (eburnation), and a deeply sunken osseous cicatrix is left behind. In other cases the walls of the pathological cavity and of the fistulous canal become covered with perfectly smooth, yellowish-white mem-

brane resembling mucous membrane, which prevents the complete obliteration of the cavity. The opening in the skin in such a case becomes closed by a black hard mass, not unlike cerumen, which furnishes a natural protection against external injuries. Microscopic examination shows these black masses to consist of epithelium, tables of cholesterine, and detritus.

If exfoliation of a large piece of bone does not take place the disease is very much prolonged, and the mastoid process may be by degrees completely or partially lost. Krukenberg¹ first called attention to the fact that the bone may be replaced sometimes by a soft, uniform, caseous mass, which can be easily cut by the knife (caseous degeneration). At the same time the mastoid process may appear swollen externally owing to an oedema of the skin.

Eburnation or sclerosis is a common result of chronic inflammations of the middle ear, especially of the purulent variety; it occurs at all ages, even in the earliest childhood. The osseous air-cells become gradually narrower and narrower, and finally disappear entirely; the *diplœ* between the *tabula externa* and *interna* becomes filled with a mass of bone, and the cortical substance is thickened by a deposit of bone on its external surface.

Sclerosis of the mastoid is also found without any indications of previous inflammation of the middle ear. This is seen especially often in extreme old age and after constitutional syphilis.

Fracture. In fractures of the skull the fissure may pass through the mastoid process and the posterior

¹ *Jahrbücher der Ambulatorischen Klinik zu Halle*, Bd. ii., S. 214.

upper wall of the meatus, without injuring the drum-membrane.

New Growths. The lymph glands lying over the mastoid process may become inflamed, increase in size, and form a well-marked lymphomatous tumor. The inflammation of these glands may occur with or after acute exanthemata and is sometimes very acute, accompanied by fever and very severe pain. The tumor may reach a large size — I have seen one as large as the fist, — is hard and extremely sensitive to the slightest touch. The skin covering it may be at the same time inflamed and infiltrated.

Arnemann reports that he has frequently seen *concretions* of a chalk-like consistency in the mastoid cells during syphilis.

Polypi often arise from the point where the tympanum passes into the mastoid cells. In the cells themselves polypoid growths of the mucous membrane are also found, usually of small size but sometimes in large numbers.

That fibrous polypi originating in the mastoid cells “sometimes appear externally behind the auricle through openings formed by exfoliation of carious bone,” as Josef Gruber asserts,¹ I have never yet satisfied myself. Possibly such were confounded with malignant tumors.

Cholesteatoma has its most common origin in the antrum mastoideum.²

Epithelial cancer can occur primarily in the mastoid process, beginning with darting pains and a red, extremely hard swelling of the mastoid. After incision or spontaneous rupture a foul ulcer is formed which

¹ *Lehrbuch*, S. 593.

² *Vide* p. 23.

rapidly becomes deep and gives rise to frequently recurring hemorrhages. After some months the hard infiltration of the neighboring lymph-glands extends to the lymph glands in the parotid which lie in front of the auricle.

THE INNER EAR.—AUDITORY NERVE.

T. C. Mürer, De Causis Cophoseos Surdo-Mutorum Indagata Difficilibus. Comment. brevis Sectionibus Cadaverum ut Plurimum Illustrata. C. tab. lithogr. Haffniæ, 1825. *Saissy*, Essai sur les Maladies de l'Oreille Interne, 1827. Translated by *Fitzler*. Ilmenau, 1829. (Deals chiefly with Diseases of the Middle Ear.) *Platner*, De Auribus Defectivis. Diss. Inaug. Anat. Pathol. Marburg, 1838 (with illustrations). *Bochdaleck*, Einige Patholog. Anatomische Untersuchungen der Gehör. und Sprachwerkzeuge von Taubstummen, als Beitrag zur Pathologie des Gehörsinns, 1839. (Abdruck in *Schmalz*, Beiträge. Heft 2. S. 124-156.) *Toynbee*, Descriptive Catalogue, etc. London, 1857. p. 75. *Menière*, Gazette Médicale de Paris. 1861. p. 598. *Voltolini*, Virchow's Archiv. XXII. 1, 2. Die Krankheiten des Labyrinths und des Gehörnerven. (Abhandlungen der Schlesischen Gesellschaft. Naturw.-med. Abth. 1862. Heft 1.) *Michel*, Memoires sur les Anomalies Congénitales de l'Oreille Interne. Gaz. Méd. de Strassbourg, 1863. No. 4. *Samuel Moos*, Plötzliche Taubheit. Wiener Med. Wochenschrift, 1863. Nos. 41-43. *Politzer*, A. f. O. II. S. 86. Ueber Läsion des Labyrinthes. 1867. *Hinton*, Observations on some of the Affections classed as Nervous Deafness. Guy's Hosp. Reports, XIII. p. 152. 1868. *Voltolini*, Kopfverletzung; vollständige Taubheit. Autopsie. M. f. O. 1869. S. 109. *Gruber*, Lehrbuch der Ohrenheilkunde 1870. S. 613-621. *A. Böttcher*, Ueber die Veränderungen des Labyrinths, etc., in einem Fall von Fibrosarcom des Nerv. Acusticus. Archiv. f. A. u. O. Bd. II. 2 Abth. See also A. f. O. VI. S. 279. 1871. *S. Moos*, Archiv. f. A. u. O. II. S. 24; III. S. 84; V. S. 245. Virchow's Archiv. Bd. 69. Heft. 2, S. 313, 1877.

Primary diseases of the ultimate structures of the acoustic nerve, and of the osseous capsule of the labyrinth, appear to be very much less common than diseases of the middle ear. Whether this is in reality the fact, or whether this infrequency is only specious on account of the concealed position and difficulty of examination of these structures, must remain for further investigation.¹

¹ *Deiters* (*Untersuchungen über die Lamina Spiralis Membranacea*,

Secondary disturbances in the circulation and nutrition of the labyrinth during disease of the middle ear, and of the brain, have been often recognized. The theory that the nutrition of the labyrinth is supported only by the exclusive vascular system of the *arteria auditiva interna*,¹ a theory which was used to explain the apparent infrequency of pathological changes in the labyrinth, has been rendered doubtful by the recent discovery of a direct connection between the vascular system of the middle ear, and that of the labyrinth through the inner wall of the tympanum. From the examination of cross-sections through the promontory, Politzer² claims to have satisfied himself of such a direct vascular connection between the tympanum and labyrinth. Further confirmation of this fact, so far as it relates to a connection between the vascular systems other than through the capillaries, is yet wanting.

Henle classifies the labyrinth of the ear under the pseudo-lymph spaces. According to Hasse, the endolymphatic cavity is in connection through the *aquæductus vestibuli* (ductus endolymphaticus), with the *liquor cereбрalis*, while the perilymphatic cavity is apparently in connection through the *aquæductus cochleæ* (ductus perilymphaticus), with the jugular lymph-system. Schwalbe,³ on the contrary, saw the space between the osseous and membranous labyrinth fill itself from the subarachnoid cavity through the *porus acusticus internus*.

The *venæ auditivæ internæ*, which pass through the *porus acusticus internus* with the *arteria auditiva interna*, and the *nervus acusticus*, empties its blood into the lower end of the *sinus petrosus inferior* or of the *sinus lateralis*. The vein contained in the *aquæductus vestibuli*, which is composed of branches from the semicircular canals, empties into the *sinus petrosus superior*, either directly or through the interposition of a *vena meningea media* (Henle).

Bonn, 1860) says, p. 11: "That he very often found changes in the *lamina spiralis membranacea*, namely, fatty degeneration, in individuals otherwise healthy, and that in man it is only exceptionally that a perfectly normal specimen comes under observation."

¹ Hyrtl found on injection of the *arteria auditiva interna* and *meningea media* with different colored waters, that the labyrinth only assumed the color used in the *arteria auditiva*, and that the rest of the temporal bone assumed the color used in the *arteria meningea media* (*Vide* Henle, *Gefäßlehre*, Braunschweig, 1876, S. 217).

² A. F. O., xi., S. 237.

³ *Med. Centralblatt*, 1869, No. 30.

The nervus acusticus arises in the medulla oblongata by two roots, one of which comes from ganglion cells on the floor of the fourth ventricle (the central acoustic nucleus, Stieda), the other arises with very thick fibres from the large-celled ganglion nucleus in the crus cerebelli ad medullam oblongatam (the lateral acoustic nucleus). This latter root just beyond its exit from the medulla has a small ganglion. The two roots unite soon into a common trunk. The course of the acoustic fibres in the cerebellum is not known; according to Meynert the fibres of the roots of the acusticus cross each other.

The membranous tissues of the labyrinth retain their forms longer and better after death than is generally supposed.¹ For their preservation, or for preparing them for microscopic examination, the following methods are used:—

(1.) Immersion in absolute alcohol after previous softening of the bone in dilute muriatic acid (Henle).

(2.) Immersion in chromic acid and potass chromate, Müller's fluid.

(3.) Immersion in a solution of a substance which itself becomes hard; according to Boettcher glue, according to Loewenberg concentrated solution of gum arabic, according to Klebs glue and glycérine in equal parts.

For the anatomical recognition of atrophy of the nerve fibres in the ultimate nervous apparatus the reaction with gold chloride is used.

For the examination of the cochlea, Waldeyer² gives the following method of preparation: "After opening the osseous covering at several spots the cochlea should be laid for twenty-four hours in a large quantity of a solution of palladium chloride (0.001 per cent.) or of perosmic acid (0.2–1 per cent.). It should then be placed in absolute alcohol for twenty hours; then decalcified by a mixture of a solution of palladium chloride (0.001 per cent.) with one tenth part of a solution of muriatic or chromic acid ($\frac{1}{4}$ – 1 per cent.). After decalcification the preparation should be again laid in absolute alcohol."

Cochleæ which have been hardened in Müller's fluid can also be decalcified with advantage after the manner of Waldeyer (Steudener.)

¹ Boettcher, *A. f. A. und O.*

² Stricker's *Handbuch*, ii., S. 958.

Malformations. In addition to the literature of this subject, mentioned under malformations of the ear in general, the following works treat specially of malformations of the inner ear.

Mundini, Anatomia Surdinati. S. 422. De Labyrinthi Auris Content.
Roederer, Descript. Foetus Paras., in Comment. Societ. Goetting. IV.
Meckel, Handbuch der Patholog. Anatomie. Bd. I. *J. G. Müller*, Annalen für Ges. Heilkunde. 1832. (Dissections of the ears of some deaf-mutes.) *Ed. Cock*, Med.-chir. Transactions. Vol. XIX. 1837. *Thurnam*, Ibid. *Nuhn*, Dissert. de Vitiis, quæ Surdo-mutitati subesse solent. Heidelberg, 1841. *Michel*, Mittheilung an die Französische Akademie. 1855. *Helie* (Nantes), Archiv. Génér. de Med. XII. 485. *Buhl* and *Hobrich*, Beitrag zur Entwicklungsgeschichte des Inneren Ohres, entnommen aus Missbildungen desselben. Zeitschrift für Biologie. 1867. *Schwartze*, A. f. O. V. S. 296. 1870. *Voltolini*, Monatschrift f. O. 1870. No. 9. Section des Gehörorgans eines Hemicephalus.

The whole labyrinth may be wanting¹ or it may be imperfectly developed. In the latter case certain parts may be wanting, as the semicircular canals² or the cochlea; or certain parts may be rudimentary³ only; or again the whole labyrinth may form a single cavity or curved canal without communication with the tympanum.⁴

Dissimilarity in the size and shape of separate portions of the labyrinths of different individuals is very

¹ Saissy, *Uebersetzung*, S. 173. External ear, drum-membrane and Eustachian tube normally formed; tympanum full of mucus. Ossicula, labyrinthine fenestræ and all parts of the labyrinth were wanting.

² Mürer, *l. c.* Tympanum, vestibule and cochlea normal; only the first portions of the semi-circular canals present; at the position where they should have been was spongy bone. Several cases by Bochdalek, (*l. c.* Fall 3, 4, 6). Voltolini (*Virchow's Archiv*, xxvii.), and others. My own observation in 1867, in a child with rachitis and premature synostosis of the skull.

³ Cochlea with $1\frac{1}{2}$ -2 spirals, without modiolus or lamina spiralis; the semi-circular canals widened or narrowed, in their middle portions impassable or ending in a blind cul de sac.

⁴ Roederer, Saissy.

common, but the shape on the two sides of the same individual is always the same, as was asserted by Meckel and confirmed by Claudius.

In one case in which there was a normal development of the external and middle ears I found an absence of the osseous and membranous labyrinths on both sides, that is, the cochleæ, vestibules, and semi-circular canals were all wanting. The trunk of the nervus acusticus ended just beyond its subdivision in a neuroma-like swelling within the bone and was in part adherent to the base of the normally movable stapes. Microscopic examination of these neuramata showed small nerve fibres crossing each other in different directions and between these fibres a small amount of loose connective tissue. The possibility of a malformation being confined to the labyrinth is recognized from a consideration of the development of this organ, for the labyrinth is developed from the labyrinthine-vesicle in the region of the cerebellum while the middle ear and external meatus are formed from the first branchial cleft and the ossicula from the first and second branchial plates. The auditory nerve which eventually unites the brain and the labyrinthine vesicle is developed independently.

Congenital Absence of the auditory nerve is extremely rare and is never found except with absence of the labyrinth. The earlier the arrest of development takes place the smaller is the meatus auditorius internus found to be.

Anæmia of the labyrinth, the anatomical recognition of which is very difficult, has been assumed to be the cause of disturbances of function in the ear which follow very depleting diseases and which are also seen

in general anæmia without other pathological changes; but it is still doubtful whether these aural symptoms cannot be referred with equal justice to changes in the intracranial circulation and a consequent imperfect perceptive power in the central organ, the brain. Anæmia certainly results from contraction (endarteritis chronica¹) and embolus of the arteria auditiva interna, a branch of the arteria basilaris, and also from aneurism of the arteria basilaris and carotis. An embolus of the basilaris was found on dissection by Prof. Friedreich of Heidelberg to be the cause of a sudden deafness in one case.

Hyperæmia in the labyrinth, of various degrees of intensity, from a net-like injection to a diffuse redness, confined to certain parts, as the vestibule² and cochlea,³ or equally distributed in all parts occurs, —

(1.) In some febrile general diseases, as typhus, puerperal fever, acute tuberculosis, and also with poisoning from carbonic oxide gas.

(2.) With acute and chronic inflammations of the tympanum.

(3.) With intracranial hyperæmias and congestions (meningitis), and with fractures of the skull.

(4.) As a passive hyperæmia in disturbances of the circulation, with disease of the heart and emphysema of the lungs, from pressure on the veins of the neck by tumors, especially those arising from scrofula, and from the lymph-glands, from pressure by tumors on the brain-sinuses which receive the venous blood of

¹ Whether the endarteritis luetica of the arteries of the brain, described by Heubner, also occurs on the arteria auditiva interna, I do not know.

² Hinton, *Supplement to Toynbee's Diseases of the Ear*, p. 461 (in hereditary Syphilis).

³ Toynbee, *Catalogue*, No. 512 (in constitutional Syphilis).

the labyrinth, from thrombus and phlebitis of the sinus petrosus superior.

(5.) As the result of disturbances in the vaso-motor innervation in hysterical persons.

Hyperæmia of the labyrinth is most commonly described in connection with inflammatory affections of the tympanum.¹ From my own anatomical investigations, I must add, however, that even with the most acute inflammations of the tympanum, a simultaneous hyperæmia of the labyrinth was met with only exceptionally.

Hemorrhage. Ecchymoses in the membranous tissues of the labyrinth are found with hyperæmias in typhus, acute tuberculosis, and variola. *Hemorrhages*² into the labyrinthine cavity and the membranous labyrinth occur with fractures of the petrous bone, with severe contusions of the skull without fracture,³ with atheroma of the arteries, with heart and kidney affections, with acute tuberculosis, typhus, scarlet-fever, measles, and, according to Toynbee, with mumps and arthritis. The extravasations produced by fractures may become purulent, and from the evacuation of the pus through the porus acusticus internus may set up a basilar meningitis.⁴ Deposits of pigment can be regarded as pathological only when very marked. In adults, a slight amount of pigment

¹ Hinton alone, *l. c.*, found it forty-one times.

² Toynbee, *Catalogue*, cases 711, 738, 752.

³ Moos (*A. f. A. and O.*, Bd. ii., S. 24) found in a gun-shot fracture of the mastoid and external meatus, together with purulent catarrh of the middle ear, and perforation and synechiæ of the drum-membrane, an effusion of blood in the membranous labyrinth, and a hemorrhagic infiltration of the perineurilemma of the nerves which lie in the lamina spiralis ossea. There was total deafness.

⁴ Politzer, *A. f. O.*, ii., S. 88.

is so often seen on the different parts of the labyrinthine tissues,¹ especially in the cochlea, in cases in which it was well known there were no disturbances of function, that it is possibly a normal condition.

Inflammation and its Results. The existence of an independent and primary, non-traumatic inflammation of the membranous labyrinth had not yet been demonstrated anatomically with certainty.² In regard to the case of Menière, described as a primary inflammation, "exsudation sanguine," in the semicircular canals and vestibule, it is doubtful whether it was anything more than a simple hemorrhage. Death is very rare during recent inflammations of the labyrinth, and from an accident only is it possible to clear up this doubt anatomically.

The following case was under my observation during the summer of 1877, and afterwards came to dissection. It places the existence of a *primary acute purulent inflammation of the labyrinth* without supuration of the middle ear beyond all doubt.

A woman, thirty-three years old, of delicate constitution, had aborted on account of constitutional syphilis, passed through a course of inunction, and remained anæmic afterwards. For some weeks she complained of headache on the right side, then of pain in the ear, dizziness, staggering gait, violent subjective noises, and frequent vomiting. Objectively there was hyperæmia of the right drum-membrane. On account of increasing pain in the ear paracentesis of the right drum-membrane was performed without evacu-

¹ Koelliker, *Gewebelehre* (1852), §§ 234, 235. Lucae, *Virchow's Archiv*, Bd. 29, S. 10.

² According to Heidenreich (*Canstatt's Jahresbericht*, 1846), the existence of an independent acute inflammation of the labyrinth was found on dissection by Biechy and Batissier (*Revue des Special, etc., Méd.-chirurg. Juillet. Revue Méd.*, S. 587). The original article was not at my command.

ating any pus. For some days there was improvement, then an increase in the pain in the head came on with a rapid rise in the temperature to 40.5 Centigrade, and the usual symptoms of acute meningitis purulenta.

The autopsy showed diffuse purulent meningitis of the base and convexity; no caries of the temporal bone, no purulent deposit on the nerve trunks in the porus acusticus internus. The drum-membrane was not perforated, the puncture having healed; the tympanic mucous membrane was a little thickened, the tympanum free from pus and of normal appearance. In the labyrinth—cochlea, vestibule, and semicircular canals—was a sero-purulent fluid, of milky appearance, which, under the microscope, showed nothing but fatty pus cells. The vessels of the semicircular canals were tensely filled and tortuous, those of the ampullæ showed the same conditions in a more marked degree, and in certain spots small extravasations were seen. The utriculus and sacculus were much swollen and infiltrated by blood and pus. The course of the labyrinthine suppuration into the cranium could not be recognized. Aside from moderate enlargement of the spleen, all the organs, both of the chest and abdomen, were free from changes which could have any bearing on the fatal disease.

From clinical observation it is probable that an acute primary and independent inflammation of the inner ear occurs not infrequently, and Voltolini¹ considers that in childhood there is a special predisposition to this inflammation. X

Secondary inflammations of the labyrinth are found with diseases of the middle ear, preferably purulent catarrhs and caries, and with diseases of the brain. The most common are *purulent inflammation*, the whole labyrinthine cavity being filled with pus and the membranous structures destroyed, while at the same time purulent inflammation or hyperæmia of the tympanum exists.² The extension of a purulent process

¹ *M. f. O.*, 1867, S. 9–14; 1868, S. 91; 1870, S. 91, 103.

² Saissy, l. c., *Uebersetzung*, S. 175. Lucae, *A. f. O.*, v., S. 190.

from the middle ear to the labyrinth takes place most easily through the labyrinthine fenestræ, the membranes of which often become perforated, or through a fistula in the labyrinthine wall of the tympanum. The labyrinth cavity has, however, been found filled with pus, without the existence of this direct communication with the tympanum, by Viricel,¹ Heller,² and Lucae,³ in cases of cerebro-spinal meningitis. Heller is inclined to consider the inflammation of the labyrinth as an extension of the meningitis (neuritis descendens) along the course of the neurilemma of the acoustic nerve on account of the hyperæmia, and ecchymoses in that tissue, and the pus cells between the nerve fibres. An extension of the suppuration in the opposite direction, that is, towards the base of the skull along the neurilemma of the acusticus, does not always result from suppuration of the labyrinth, as the pus may become inspissated, caseous, and remain a long time in the labyrinth without injury. This is shown by many cases of caries, and also by old observations in deaf-mutes.⁴ In other cases the suppuration of the labyrinth produces necrosis of that organ. In a case of caries of the labyrinth-wall in a tuberculous subject, which had healed, Wendt⁵ found not only detritus in the labyrinth, but a closure of the inner meatus by connective tissue, which afforded a natural protection against the extension of the suppuration towards the base of the brain. The nerve trunks in the inner meatus were not destroyed.

¹ Quoted by Saissy, S. 175.

² Heller, *Deutsches Archiv für Klinische Medicin*, 1867, Band iii., S. 482.

³ *A. f. O.*, v., S. 188.

⁴ *Memoirs of the Medical Society of London*, vol. iii., S. 1.

⁵ Case 344 a, of his collection of anatomical preparations.

In its lighter forms the inflammation of the labyrinth does not go on to suppuration, but only produces a small cell infiltration, that is, an infiltration of lymphoid corpuscles, in the membranous labyrinth, such as Moos¹ has described in cases of caries of the temporal bone, and of typhus, variola, and scarlet fever associated with inflammation of the tympanum.

That disturbances of nutrition in the ultimate nerve-apparatus of the labyrinth, takes place from the continuous intralabyrinthine pressure which must necessarily result from many diseases of the middle ear, is highly probable. The anatomical proofs of this are however as yet very few.

As the *results* and remains of chronic inflammation, the following changes have been seen and described: swelling, thickening and atrophy of the membranous labyrinth, fatty degeneration of Corti's organ,² connective-tissue growths on the saccule and utricle of the vestibule,³ growths of connective tissue from the osseous to the membranous labyrinth, filling of the labyrinthine cavity with a thick, yellowish-white mass resembling detritus or with a reddish soft mass of tissue, calcifications, ossifications,⁴ and hyperostoses, collections of pigment and cholesterine, and changes in the labyrinth water which is found hemorrhagic,⁵ jelly-like,⁶ opaque, diminished and increased. Also

¹ Moos, *A. f. A. und O.*, iii., 1, S. 84; *Ibid.*, v., S. 245 and 246.

² Moos, *vide A. f. O.*, ix., S. 298, 299.

³ Schwartze, *A. f. O.*, iv., S. 245.

⁴ Hinton describes an ossification of the saccule. Moos (*A. f. O.*, ix., S. 276, Fall 8.) found with ankylosis of the ossicula in secondary syphilis a deposition of lime concretions on the saccules of the vestibule and on the semicircular canals.

⁵ Gruber, *Lehrbuch*, S. 617, note.

⁶ Otto, *l. c.*

the abnormal increase or diminution of the lime crystals, otoliths, in the semicircular canals and the sacs of the vestibule, have been referred to inflammatory processes.¹

The use of these lime-crystals and the corpora amylacea, which are often present in large numbers, is unexplained, and at least they should not be used to account for marked disturbances of function. Lucae² found masses of fat and lime in the ampullæ and vestibular sacs in a case of acute purulent inflammation of the inner ear with meningitis epidemica, where good hearing existed before the fatal disease. In another case Lucae³ found the membranous semicircular canals completely filled with lime-crystals where there had been no inflammation in the ear.

Voltolini⁴ is of the opinion that not only the increase of the otoliths may be the result of a "perverted nervous influence" (namely, in inflammatory conditions of the inner ear, as caries) but that abnormal forms of these crystals may also be produced by these same influences. Usually these crystals are hexagonal columns truncated at the ends, but Krause⁵ has seen them octohedral, and Voltolini prismatic in form.

Caries and Necrosis.

Literature, of Necrosis of the Labyrinth. *Wilde*, Pract. Bemerkungen, etc., Uebersetzung. S. 432. *Menière*, Gaz. Med. de Paris, 1857, No. 50. *Von Troeltsch*, Virch. Arch. XVII. S. 47. *Toynbee*, A. f. O. I. S. 112, with a supplement at S. 158. *Gruber*, Allgem. Wiener Med. Ztg. IX. 41-45. *Voltolini*, M. f. O. IV. S. 85. *Schwartz*, A. f. O. IX. S. 238. *Boeters*, Inaugural-Dissertation, Halle, 1875. *Dennert*, A. f. O. X. S. 231. *Lucae*, Ibid. S. 236.

In very exceptional cases a caries, confined to the labyrinth without the other portions of the temporal bone showing any sign of the disease, is found. An

¹ Pappenheim and Voltolini.

² A. f. O., v., S. 189.

³ Virchow's Archiv, xxix., S. 44.

⁴ Ibid., xxii., S. 126.

⁵ Bock's Anatomie, 2 Aufl., ii., S. 217.

old observation of this disease with a figure is given by Platner,¹ who found a carious opening in the wall of the posterior semicircular canal in an ear otherwise healthy. From carious destruction of the osseous capsule of the labyrinth at any spot an incurable deafness results, owing to the loss of the labyrinth water and destruction of the ultimate nervous apparatus.

Necrosis confined to the labyrinth is more common, and is seen in different stages from the line of beginning demarcation to the complete separation and discharge of the diseased bone. Childhood seems to be specially predisposed to this.

Cases of necrotic separation of the cochlea, either alone or with the contiguous parts of the semicircular canals, have been described most frequently. In other less common cases, the necrosis affects the whole labyrinth, so that the entire pyramid including the cochlea, vestibule, and semicircular canals, is separated from its attachments, and its removal is not inconsistent with life, provided that the process of demarcation has not already produced a fatal disease of the meninges of the brain. The first case of this kind was published by Wilde.

The usual course which a sequestrum of this kind takes, is through the labyrinth wall of the tympanum, into that cavity, and from there into the meatus.

Niemetschek, in Prague, has observed one case where the necrotic labyrinth was thrown off through the nose.

A beginning necrosis of the labyrinth can be recognized by the very decided white color of the bone at the affected spot, and by the line of demarcation

¹ Given in Schmalz, *Beiträge*, i., S. 175.

surrounding this spot. Along this line of demarcation the bone is softened, or already at certain spots separated. Later on in the process, a new growth of bone is seen near this line. The relative frequency



Fig. 65.

Necrosed Cochlea discharged during life.

Fig. *a* shows a completely separated sequestrum including the cochlea, from the pyramid of a child two and one half year's old, which died from tubercular meningitis. It is magnified three times, and shows the sequestrum when looked at from the upper surface. The upper half of the illustration shows the first spiral of the cochlea, which on the right passes into the second spiral. On the left of the illustration a remnant of compact osseous substance is recognized, which belonged to the anterior wall of the petrous bone above the canalis caroticus. On the edge of the posterior side of the preparation, a trace of the meatus auditorius internus remains. The carotid artery and jugular vein were uninjured.

Fig. *b* shows the necrosed cochlea of a man thirty-eight years old. The modiolus with its base turned towards the meatus auditorius internus can be seen; from this a layer of bone projects which corresponds to the inner wall of the first and the outer wall of the second spiral of the cochlea. The lamina spiralis ossea can be traced in the preparation for nearly one and a half spirals. In this case complete recovery took place, leaving total deafness of this ear, and dizziness on violent movement. There was no facial paralysis.

Fig. *c* shows two views of a necrosed cochlea with the whole modiolus, thrown off during life by a young woman; one view is taken from the apex, and the other from the side. The formation of the lamina spiralis ossea, is perfectly retained. Magnified three times.

of circumscribed necrosis of the labyrinth is explained by the separate development, separate nutrition, and very early ossification of this part. It is, in most cases, caused by a caries of the spongy por-

tion of the pyramid which surrounds the compact bone of the labyrinth, or else it is caused by the perioritis purulenta within the labyrinth which, as we have seen, results from suppuration of the tympanum. In the very rare cases which run an acute course, and are not preceded by a long otorrhœa, the cause of the necrosis is perhaps an embolus of the arteria auditiva interna.

New Growths in the Labyrinth. New growths of connective tissue have been already described under inflammation. Exostoses have been several times found in the vestibule, three times by Toynbee, and an old case of this kind is described by Platner.¹ In the cupola of the cochlea, Voltolini² found a "fibromuscular" tumor. A doubtful granulation-like sarcoma in the vestibule was described by me.³

In the vestibule, and almost filling that cavity, lay a mass of tissue of a dark-red color; this could be picked to pieces with the greatest difficulty, and showed under the microscope very numerous blood-vessels laying in a tissue composed, for the most part, of small, generally round or oval cells, and a small amount of fibrous intermediate substance. There was no pus in the vestibule; its osseous walls were healthy, except a spot of caries the size of a pea, on the lower wall in the centre of the otherwise healthy pars petrosa.

Whether *cholesteatoma* occurs primarily in the labyrinth, is doubtful. Boettcher suspects it may arise from the epithelium of the aquæductus vestibuli. A cholesteatoma arising from the tympanum can extend to the labyrinth secondarily.

In the membranous semicircular canals, small elevations, papillæ, of the pavement epithelium on the basal membrane, occur, which

¹ *De Auribus Defectivis, Diss. Inaug.*, Marburg, 1838, with an illustration.

² *Virchow's Archiv*, xxii., 1, 2.

³ *A. f. O.*, ii., S. 285.

are considered by Lucae¹ to be pathological formations, but by Rüdinger,² are described as normal villi of these canals. Recently they have been considered normal by Utz³ also, on account of their constant existence and their regular arrangement and development. In new-born children these prominences do not exist.

Tuberculosis of the inner ear (cochlea and semi-circular canals), an extension of the same disease from the tympanum, occurs frequently in pigs, according to Schütz.⁴ The growth may extend from the labyrinth into the connective tissue of the nervus acusticus, and thus reach the meatus internus and the cranial cavity.

Injuries. The labyrinth is so protected by its situation and its osseous capsule, that direct injuries reach it only in very rare cases; indirect injuries, on the contrary, are common in fractures of the skull, which extend through the petrous bone, producing effusion of blood and laceration of the membranous labyrinth. Direct injuries from the penetration of needles or other sharp substances into the inner ear, with penetration of the labyrinth wall, fracture of the stapes, and laceration of the soft parts of the vestibule, have been reported in very small numbers. A case of this kind will be found in the "Gazette des Hôpitaux," 1857, No. 130 with the autopsy, which showed an extravasation of blood on the petrous bone, and purulent meningitis. In a dog a spike of grass was once found which, entering the meatus and tympanum, penetrated to the cochlea. Lesions of

¹ *Virchow's Archiv*, xxvii., S. 169.

² *A. f. O.*, ii., 1867.

³ *Beitrage zur Histologie der Häutigen Bogengänge, etc.*, München, 1875.

⁴ *Virchow's Archiv*, Bd. 66, S. 93.

the inner ear, with fatal result, are more commonly caused by the pouring into the meatus of concentrated mineral acids, or of molten metal, with a criminal intent.¹

With fissures in the pars petrosa which pass through the inner ear, there is a discharge of serous fluid from the meatus if the membrana tympani has been injured, or if the fissure has extended to the walls of the meatus. It has already been remarked, on page 20, that this injury is not necessarily fatal. In all cases, however, absolute deafness results, and if the fissure extends through both petrous bones, as sometimes occurs, the deafness is bilateral.

Diseases of the Auditory Nerve. Congenital absence of the auditory nerve beginning at its point of entrance into the petrous bone has only been noticed with simultaneous absence of the labyrinth. Acquired loss of the branches of the auditory nerve may result from inflammation and from new growths.

Hyperæmia of the neurilemma is seen as a post-mortem change, but it also occurs with neuritis.²

Old and recent apoplexies in and around the trunk of the nerve have been observed after injuries, and also in connection with fatty degeneration of Corti's organ (Moos).

Atrophy as a secondary process in the nerve trunk or its branches is only known to take place from disease of the parts of the brain from which the nerve originates, cerebellum, fourth ventricle, medulla ob-

¹ Osiander, *Ueber den Selbstmord*, S. 395, narrates the case of an Englishwoman who killed six husbands, one after another, by pouring molten lead into the ears when they were asleep.

² Compare p. 168.

longata; from hydrocephalus internus, from apoplexy and softening of the brain, or from atrophy of those parts to which it is distributed, *i. e.* the ultimate nervous apparatus.¹ Atrophy from this latter cause appears to be developed often from the loss of function of the peripheral conducting apparatus. It is also caused by the pressure of tumors at the base of the skull, by tumors of the brain, by extravasations of blood in the porus acusticus internus, by periostitis of the porus acusticus,² and by neuritis.

According to Erb³ atrophy of the acusticus now and then occurs with tabes. I myself have never seen such a case. Whether the disturbances in the nervus acusticus,⁴ which were observed by Duchenne and Bourdon, were dependent on the extension of the pathological process to the base of the skull, was not decided. Lucae, who alone has reported accurate dissections of the ear in cases of gray degeneration of the spinal cord with deafness, says that he found no disease in the acusticus.⁵

× From long-continued loss of function in the peripheral apparatus, especially from ankylosis of the stapes

¹ According to O. Weber (Pitha and Billroth, i., S. 344), when the inner ear has been destroyed the acusticus does not show atrophy, but, as a rule, fatty degeneration, which may extend even into the parts of the nerve within the brain.

² According to Beck (*Krankheiten des Gehörorgans*, S. 120, 124), this was observed by Soemmering. Toynbee, *Catalogue*, 791, 792. Zeissl, *Constitutionelle Syphilis*, Erlangen, 1864, S. 297. A case of paralysis due to compression, and of atrophy, produced by an osseous constriction of the meatus auditorius internus from periostitis ossificans syphilitica. Hinton, *Guy's Hospital Reports*, 1867 : two cases.

³ *Krankheiten des Rückenmarks in Ziemssens Handbuch*, xi., 2, 1 Abtheilung, S. 142.

⁴ Friedreich, *Degenerative Atrophie der Spinalen Hinterstränge*.

⁵ Compare *A. f. O.*, ii., S. 305.

associated with immobility of the membrane of the fenestra rotunda, is often developed a centripetal progressive atrophy; this, however, is by no means a constant result. Haighton found atrophy of the nerve associated with inspissated pus in the labyrinthine cavities.

Tumors may force themselves into the porus acusticus, produce atrophy of the nerve trunk, and, in addition, as Boettcher¹ found, may produce atrophy in the nerve-fibres and ganglion cells of the ultimate nervous apparatus of the labyrinth, and also complete disappearance of the inner and outer hair-cells, while all the other parts of the ultimate acoustic apparatus of the cochlea remain intact. Tumors may also produce a very decided enlargement of the osseous canal and extensive destruction in the petrous bone.²

Neuritis of the acusticus has been proved to exist only with fissure of the petrous bone, with caries and with cerebro-spinal meningitis. The nerve trunk is reddened and swollen, surrounded with and infiltrated by pus, and in the more advanced stages of the disease is softened and destroyed.

The presence of a large amount of corpora amylacea between the nerve-fibres of the trunk of the acusticus, which has been falsely designated³ "amyloid degeneration of the acusticus," is generally to be regarded as an accompaniment of atrophy of the nerves.⁴ The corpora amylacea are seen associated

¹ Vide *A. f. O.*, vi., S. 279.

² An instance of this is seen in Figure 10.

³ Voltolini, *Virchow's Archiv*, xviii., xx., xxii.

⁴ G. Meissner, *Zeitschrift für Rat. Med. N. F.*, iii., 3, 1853. Foerster, *Atlas der Path. Histologie*, 1856, Taf. xviii. The histological details are most accurately given by Schweigger-Seidel. (*Virch. Arch.*, Bd. xxii., S. 114.)

with nucleated cells lying in the hypertrophied intermediate-substance of the nerves, which is formed of connective tissue (nucleated connective tissue, processes of spindle-cells); the nerve fibres themselves appear to have undergone fatty degeneration and to have disappeared. It should be added that these corpuscles are found in variable quantities in the trunk of every normal nerve.

The supposition of Hyrtl¹ that atrophy of the acusticus is found in all deaf-mutes is incorrect.

Fibrous degeneration may lead to hardening of the nerve so that it becomes firmer than the facialis.

New growths in the trunk of the acusticus, or its branches, ramus cochleæ et vestibuli, are reported as follows:—

Fibromata were found by Gruber,² especially with caries of the temporal bone. The ganglion-like swellings on the ramus cochleæ, which were found by Fleischmann³ probably also belong to this category. In a case by Lévêque-Lasource,⁴ a fibroma fourteen lines in diameter occupied the meatus internus of an old woman who had become gradually deaf and blind.

Sarcomata are quite common on the acusticus, according to Foerster.⁵ A case is given by Voltolini,⁶ and by Moos.⁷

Neuromata. Cases are given by Virchow,⁸ and

¹ *Topogr. Anatomie*, 1857, i., S. 228.

² *Lehrbuch*, S. 545.

³ *Hufeland's Journal*, 1840, Heft 1.

⁴ Lincke, *Handbuch der Ohrenh.*, i., S. 651.

⁵ *Würzb. Med. Zeitschrift*, iii., S. 199.

⁶ *Virchow's Archiv*, xxii., S. 125.

⁷ Compare *A. f. O.*, ix., S. 298, with fatty metamorphosis and partial loss of Corti's organ.

⁸ *Geschwülste*, ii., S. 151, iii., S. 295.

by Klebs.¹ A number of the so-called neuromata of the acusticus arise in reality from the neuroglia, and are therefore to be referred to the gliomata.²

Gummata of the brain or base of the skull may affect the trunk of the acusticus.³

Concretions of carbonate of lime were found by Boettcher⁴ on the periosteum of the porus acusticus internus and also in the neurilemma, particularly in persons of middle age.

Tumors of the petrous bone, which arise from the dura mater, may produce compression, consequent atrophy, and complete destruction of the trunk of the nerve. In a child aged two years, I found a mass of tubercle, the size of a pigeon's egg, arising from the dura mater, and lying at the entrance of the meatus auditorius internus, which had produced paralysis of the facialis and acusticus by compression: there was no caries.⁵

Virchow⁶ figures a psammoma of the dura mater as large as a mulberry, which was attached by a broad base at the entrance of the meatus internus, extended a short distance into the osseous canal, and had produced paralysis of the facialis and acusticus by compression.

Rayer⁷ describes a case of unilateral deafness apparently due to a syphilitic tumor as large as a pigeon's egg in the fossa of the petrous bone.

¹ *Prager Vierteljahresschrift*, 1877, S. 65. The tumor filled the inner meatus. The facialis had completely disappeared in the tumor; the acusticus remained distinct.

² Virchow's *Geschwülste*, ii., S. 151.

³ *Ibid.*, S. 463.

⁴ *Virchow's Archiv*, Bd. xvii., S. 104.

⁵ *A. f. O.*, v., S. 296.

⁶ *Geschwülste*, ii., S. 116.

⁷ Gross and Lancereaux, *Affect. Nervi Syphil.*, Paris, 1861, S. 381.

Other *intracranial processes*, both basilar and cerebral, which may produce disease of the acusticus, are: basilar meningitis, by pressure of its exudation on the oedematous, softened nerve trunk, or by cicatricial contraction of the arachnoid membrane; aneurism of the *arteria basilaris*;¹ hydrocephalus internus; tumors of the brain.²

According to Calmeil, disturbances of hearing occur in one ninth of all cases of tumors of the brain. According to the tables of Ladame,³ in seventy-seven cases of tumor of the cerebellum, disturbances of hearing occurred seven times; in twenty-six cases of tumors of the pons they occurred seven times; in twenty-seven cases of tumors of the middle lobes, three times; on the other hand, no disturbances of hearing occurred in twenty-seven cases of tumors of the anterior lobes, in fourteen of the posterior lobes, and in four of the fourth ventricle. In a number of tumors of the brain unilateral disturbances of hearing were the first symptoms of the disease, as has been shown by Cruveilhier. Tumors of the cerebellum not infrequently produce bilateral total deafness, beginning first on the side corresponding to the tumor; and this bilateral deafness may occur even in cases where a direct pressure of the tumor on the nerve trunk of the second ear or on its nucleus in the medulla oblongata is utterly impossible, and where other symptoms of paralysis of other nerves of the brain or spinal cord on the second side are also wanting. Per-

¹ Toynbee, *Catologue*, No. 772. Griesinger, *Archiv für Heilkunde*, 1862, 6 Heft. Lebert, *Berliner Klin. Wochenschrift*, 1866.

² An old case by Lincke, *Handbuch der Ohrenheilkunde*, i., S. 650-653.

³ *Symptomatologie und Diagnostik der Gehirngeschwülste*, Würzburg, 1865.

haps in such cases there exists a neuritis of the ultimate nervous apparatus in the labyrinth, or possibly only an interference of function due to fluxionary oedema.

Brückner¹ describes a case of tumor within the skull where the auditory nerve trunk was completely torn across by the dragging of the mass. As the results of fractures of the skull, a similar tearing of the nervous acusticus with an intact facialis has been found.

As a cause of deafness, in addition to the direct compression of the nerve trunk by a tumor and compression of the parts of the brain from which the nerve arises, should be mentioned softening of the brain-substance in the neighborhood of the tumor at its point of insertion in the brain. It should also be remembered that simultaneously with the brain disease, peripheral disease in the conducting apparatus may occur which alone may be sufficient to account for the disturbances of function. Especially, often I have found ankylosis of the stapes associated with atrophy of the brain (*dementia paralytica*), and also with tumors of the brain.²

Pathological changes in the fourth ventricle appear to have much less influence in producing disturbances of hearing than was formerly supposed. Thickening of the ependyma, which has been spoken of as something of importance³ in the dissection of deaf-mutes, is very commonly found in various diseases of the

¹ *Berliner Klin. Wochenschrift*, 1867, No. 29.

² Vide *A. f. O.*, ii., S. 289, Fall 8.

³ H. Meyer, *Zur Anatomie der Taubstummheit*, *Virch. Arch.*, xiv., 5, 6, p. 551, 1858. Voltolini, *Ibid.*, xxvi., S. 171, 1863. Falk, *Zur Statistik der Taubstummen*, *Arch. f. Psychiatrie*, iii., S. 418.

brain, especially in insane persons, where not the slightest disturbance of hearing existed: when found in deaf-mutism it can be considered only as an incidental appearance. Tumors in the fourth ventricle have been found several times without any disturbance of the hearing having existed.¹ Even complete absence of the *striæ acusticæ* is not, according to Engel, accompanied by deafness.²

Disturbances of the ear are but rarely the result of hemorrhages in the brain, or of encephalic collections; according to Moos they are most common with unilateral apoplexy in the pons. Whether they may also be produced temporarily by simple hyperæmia of the brain and its membranes (arterial fluxion with œdema or venous congestion) is, to judge from clinical observations, certainly probable, but has, however, never been recognized anatomically. As Bottcher³ has already said, very continuous and laborious work is still needed in order to throw more light anatomically on cerebral deafness. After previous hardening of the brain the whole region where the central ganglia lie, from which the fibres of the acusticus arise, must be successively dissected.

¹ Ladame, *Symptomatologie und Diagnostik der Hirngeschwülste*, Würzburg, 1865. In four tumors of the fourth ventricle no disturbance of hearing. Foerster, *Würzb. Med. Zeitschr.*, Bd. iii., Heft 3. Cysticercus in the fourth ventricle. Hydrocephalus internus.

² *Wiener Wochenschrift*, 1862, No. 60.

³ Boettcher, *Archiv f. A. u. O.*, ii., 2.



